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RIFLE SQUAD ARMED WITH A LIGHT WEIGHT HIGH VELOCITY RIFLE

FINAL REPORT

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FINAL REPORT

LIGHTWEIGHT HIGH-VELOCITY

RIFLE EXPERIMENT

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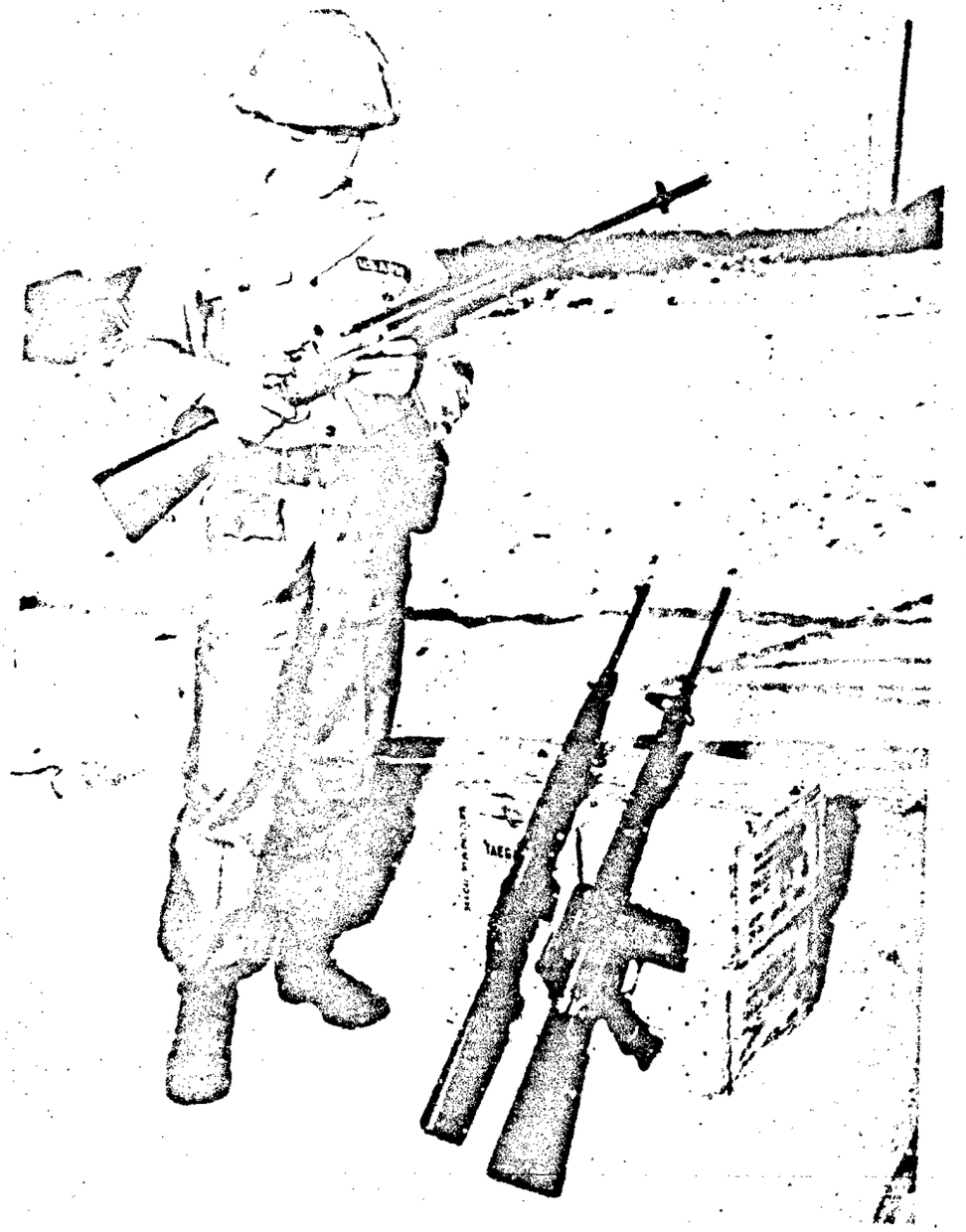

PROJECT ARMORER INSPECTING RIFLES USED IN LIGHTWEIGHT HIGH-VELOCITY RIFLE EXPERIMENT

Form 1473

US ARMY COMBAT DEVELOPMENT EXPERIMENTATION CENTER
Fort Ord, California

(1) RIFLE SQUAD
ARMED WITH
A LIGHTWEIGHT HIGH-VELOCITY RIFLE .
(CDCG, CDEC 58T9)

(9) FINAL REPORT. 1 Dec 58 – 22 Mar 59.
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Regraded
"For Official Use Only"
15 June 1961

ROBERT E. CONNOR
Colonel, GSC
Chief of Staff

(037 210)

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ABSTRACT

The Lightweight High-Velocity Rifle Experiment tested the performance of various sized squads firing the M-14 rifle, caliber .30 (NATO), the Winchester lightweight rifle, caliber .224, and the Armalite lightweight rifle, caliber .222. The objectives were to determine the most effective squad size, the most desirable rifle system, the best fire technique to be used, and the optimum combination of these factors. Over 500 firing runs were made on attack and defense ranges. Fire techniques studied included all automatic, all semi-automatic, and selected combinations of automatic and semi-automatic fire. Results of the experiment indicated that a five to seven-man squad equipped with a lightweight high-velocity rifle would have a greater target hit potential than an eleven-man squad armed with the M-14 rifle. In this analysis, the lethality of the individual rounds was assumed to be the same for the M-14 and the lightweight rifles.

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Letter, ATSWD-G 353.01/25 (ATT) (CONFMOD), Hq CONARC, 29 August 1958, Subject: "Directive for an Experiment with the Rifle Squad Armed with a Lightweight, High-Velocity Rifle (LWHVR) (U)".

CONTRACTUAL AGREEMENT

Scientific support was provided by the Research Office of the Experimentation Center staffed and operated by Stanford Research Institute, Menlo Park, California, under Department of the Army Contract No. DA 04-331-AVI-1465.

ACKNOWLEDGMENT

The US Army Combat Development Experimentation Center (USA CDEC) is indebted to the United States Army Infantry Board, Fort Benning, Georgia, for data obtained from the series of publications entitled Evaluation of Small-Caliber High-Velocity Rifles - Winchester and Armalite AR-15, Project No. 2787. These publications were the source of much of the data for the Logistical Analysis contained in this report. They were used also for reference purposes throughout the experiment.

SECTION I

GENERAL INFORMATION

1. INTRODUCTION

Fundamentally the Lightweight High-Velocity Rifle Experiment was an exhaustive comparison of target hit performance, in simulated attack and defense situations, of squads armed with the US Rifle M-14, caliber .30 (7.62mm - NATO); the Armalite AR-15 Rifle, caliber .222; and the Winchester Lightweight Military Rifle, caliber .224. The experiment was conducted by the US Army Combat Development Experimentation Center during the period 1 December 1958 - 22 March 1959 on firing ranges at Hunter Liggett Military Reservation and Fort Ord, California.

The design of the experiment established a schedule for measurement of differences between the weapon candidates on the basis of relative target hit capabilities. Influences of extraneous factors were reduced by balance of the variables. The design also provided for objective evaluation of various techniques of fire under both day and night conditions and investigation of the effects of various aids to firing. Concurrently in every phase four different squad sizes were examined to accumulate data bearing on the determination of an appropriate size for the combat squad insofar as the rifle affects squad organization.

2. PURPOSE

As directed by Hq CONARC, the purpose of the Lightweight, High-Velocity Rifle Experiment was a., "to compare the relative effectiveness of variously organized rifle squads armed with M-14 rifles and the Winchester and Armalite lightweight, high-velocity rifles", and b., "to determine the impact of the lightweight, high-velocity rifles on squad organization, techniques, and logistics".

3. OBJECTIVES

a. To determine the relative effectiveness of variously organized rifle squads armed with the M-14 rifle and the Winchester and Armalite lightweight high-velocity rifles.

b. To determine the impact of the lightweight high-velocity rifle system on the following:

(1) Organization of the squad.

(2) Techniques of fire.

(3) Logistics.

4. SCOPE

a. In order to accomplish the stated purpose of the LWHVR experiment, USA CDEC investigated the performance of rifle squads, as influenced by squad size and rifle type, in terms of the ratio of number of hits to number of rounds fired and the ratio of number of different targets hit to number of hits. (These criteria are called "hit probability" and "hit distribution", respectively.)

b. The following areas were examined in the experiment:

(1) Squad Size

(a) 5 men

(b) 7 men

(c) 9 men

(d) 11 men

(2) Rifle Type

(a) Winchester

(b) Armalite

(c) M-14

(3) Fire Technique

(a) Automatic

(b) Semi-Automatic Fire

(c) Specified Combinations of Automatic Fire and Semi-Automatic Fire

(4) Tactical Phases

(a) Daylight Attack

(b) Daylight Defense

(c) Night Defense

(5) Aids to Firing

(a) Bipods

(b) Tracer Ammunition

(6) User Opinion of Weapons Tested

(7) Logistical Impact of the LWHVR System

5. CONCLUSIONS

a. With a total combat weight per man equivalent to that planned for riflemen armed with the M-14, a squad consisting of from 5 to 7 men armed with the LWHVR system would have better hit distribution and greater hit capability than the present eleven-man M-14 squad. Furthermore, employment of the smaller squad armed with the lightweight rifle system would permit more economical use of manpower on the battlefield.

b. By opinion poll, the experimentation troops favor the LWHVR system, as represented by the Armalite, because of its demonstrated characteristics of lightness in weight, reliability, balance and grip, and freedom from recoil and climb on full automatic (ease of firing).

c. The Winchester rifle is comparable to the M-14 in hit probability.

d. The Armalite rifle is comparable to the M-14 in reliability.

e. Both candidate weapons of the lightweight high-velocity rifle system are superior to the M-14 in hit distribution.

f. The presently developed representatives of the lightweight high-velocity rifle system require the following improvements before further experimentation with them should be considered:

(1) Winchester Lightweight Military Rifle, caliber .224, must be redesigned so that the component parts, including the bolt assembly, are strengthened and made more resistant to breakage, to bring the functional reliability equal to or above that of the M-14.

(2) Armalite, AR-15, caliber .222, must be modified and improved, with special emphasis on the sights, to bring the

hit capability equal to or above that of the M-14.

g. Automatic fire with an LWHV rifle appears to have exceptional tactical value when the rifle is fired in short bursts (three to six rounds) on full automatic.

h. The attributes demonstrated by the prototype weapons of the lightweight high-velocity category indicate an overall combat potential superior to that of the M-14. Such advantages include: inherent characteristics of lightness in weight of arms and ammunition, ease of handling, superior full automatic firing capability, accuracy of the Winchester, and functional reliability of the Armalite.

5. RECOMMENDATIONS

a. That emphasis be placed on the development of a lightweight high-velocity rifle combining the accuracy characteristics of the Winchester with the reliability characteristics of the Armalite, and not exceeding the weapon/ammunition weight of either.

b. That such a lightweight high-velocity rifle be developed with a view toward early replacement of current rifles.

c. That concurrent with the adoption of a lightweight high-velocity rifle, serious consideration be given to reduction in the size of the present squad with resultant great saving in manpower.

SECTION II

DESCRIPTION OF EXPERIMENT

1. GENERAL

a. The Lightweight High-Velocity Rifle experiment was conducted in four phases:

Phase I - daylight attack, semi-automatic fire

Phase II - daylight defense, semi-automatic fire

Phase III - night defense, automatic and semi-automatic fire

Phase IV - daylight defense, automatic and semi-automatic fire

(1) Phase I, daylight attack, consisted of a series of 144 runs in which squads of various experimental size traversed two transition-type ranges and fired against silhouette targets which were dispersed in tactical attitudes throughout the ranges (Figure 1). Each course was traversed 72 times by experimental squads. This provided a volume of data for comparison of squad performance with each of the three rifles under consideration. During the daylight attack phase, the riflemen employed semi-automatic fire only.

FIGURE 1

RIFLEMEN AND DATA COLLECTORS, ATTACK RANGE

(2) A field firing range equipped with retractable (pop-up) silhouette targets in various arrays at three different distances from a firing line was used for all defense-phase experimentation (Figure 2). Experimental squads of various sizes fired each of the three types of rifles against the retractable target arrays to their front. During the daylight portion of the defense phases, 287 firing runs were accomplished. During the night defense phase, 128 were accomplished. Automatic fire, semi-automatic fire, and specified combinations of both types of fire were tested on both day and night defense phase experimentation.

FIGURE 2

RIFLEMAN AND DATA COLLECTOR, DEFENSE RANGE

2. DESIGN CONSIDERATIONS

Since the objective of the experiment was to compare different combinations of squad organization and armament, it was essential that the design provide for a determination of the interaction effects -- that is, for specific calculation of the influences of these factors, one upon the other, in various combinations. By repeating measurements two or more times on each combination of squad organization and rifle type, this requirement was satisfied. (See Annex A, Designs of Experiment.)

However, the experimental designs had to take into account not only the experimental factors under direct consideration, but also the influence of those attendant variables which could not be eliminated. These included progressive changes in temperature and light throughout the day, human efficiency trends within the work day, and the learning factor associated with continual repetition of a problem. In order to achieve experimental balance, i.e., and even distribution of these secondary influences, the basic experimental factors were tested repeatedly and in such combinations and sequences as to provide that:

a. All were exposed in virtually equal degree to the cyclic changes of day mentioned above.

b. All were tested against all target arrays, which were varied in numbers and points of appearance so as to minimize troop learning of their positions.

c. All weapon types were employed an equal number of times during first and last runs of the day, when experimentation personnel might be expected to function least effectively.

Possible differences between squads in average firing proficiency had to be taken into account for any realistic comparison of squad organizations. Individual firing records were used in assigning squad members so that all squad organizations within a given platoon were allotted approximately equal shares of available talent. Rotation of individual firers between squad organizations helped further to balance out this factor. Complete rotation was not possible, but neither was it vital. (See Figures 11 and 12.)

3. FIRING RANGES

a. Attack Ranges

For the attack phase of the LWHVR experiment, two

firing ranges were established at Hunter Liggett Military Reservation. Each range was roughly rectangular -- about 110 yards wide by 350 yards long in actual ground distance. The terrain of Attack Range No. 1 was composed of steep hills and cliffs and was covered with large boulders and thick tree growth (Figures 3 and 4). Attack Range No. 2 was almost flat, rocky, and interspersed with bushes and occasional trees (Figures 6 and 7). Each range provided a total of 77 targets, each target having three varying positions within the same general area. By designed rotation of the targets throughout the three positions and by alternate use of Ranges No. 1 and No. 2, experimentation forces were deterred from anticipating target locations. The target rotation scheme and relative distances of targets from successive firing lines are as shown in Figures 5 and 8.

Targets on the attack ranges were of two types: "E" - type, about 3-1/2 feet high, which represented the frontal silhouette of a man in a crouching or kneeling position, and "F" - type, about 1-1/2 feet high, which represented the frontal silhouette of a man in the prone position. The targets were positioned on the ranges and camouflaged to simulate enemy troops on a defensive mission.

b. Defense Range

For the day and night defense phases, a field firing range at Fort Ord was employed. This range was on sloping terrain with no undergrowth and consisted essentially of a stationary firing line made up of revetted foxholes and three rows of targets at distances of 300, 200, and 100 yards from the firing line (Figures 9 and 10).

All targets were E-type silhouettes mounted with a system of hinges, cables, and levers so that they could be made to pop-up in various arrays as prescribed by commands given to target controllers, who were located in pits approximately in the center of each line of targets. The targets were arranged in this manner:

Range	Total No. Targets	No. Target Arrays	No. Targets Each Array
300 yards	32	4	8
200 yards	20	2	10
100 yards	10	2	5

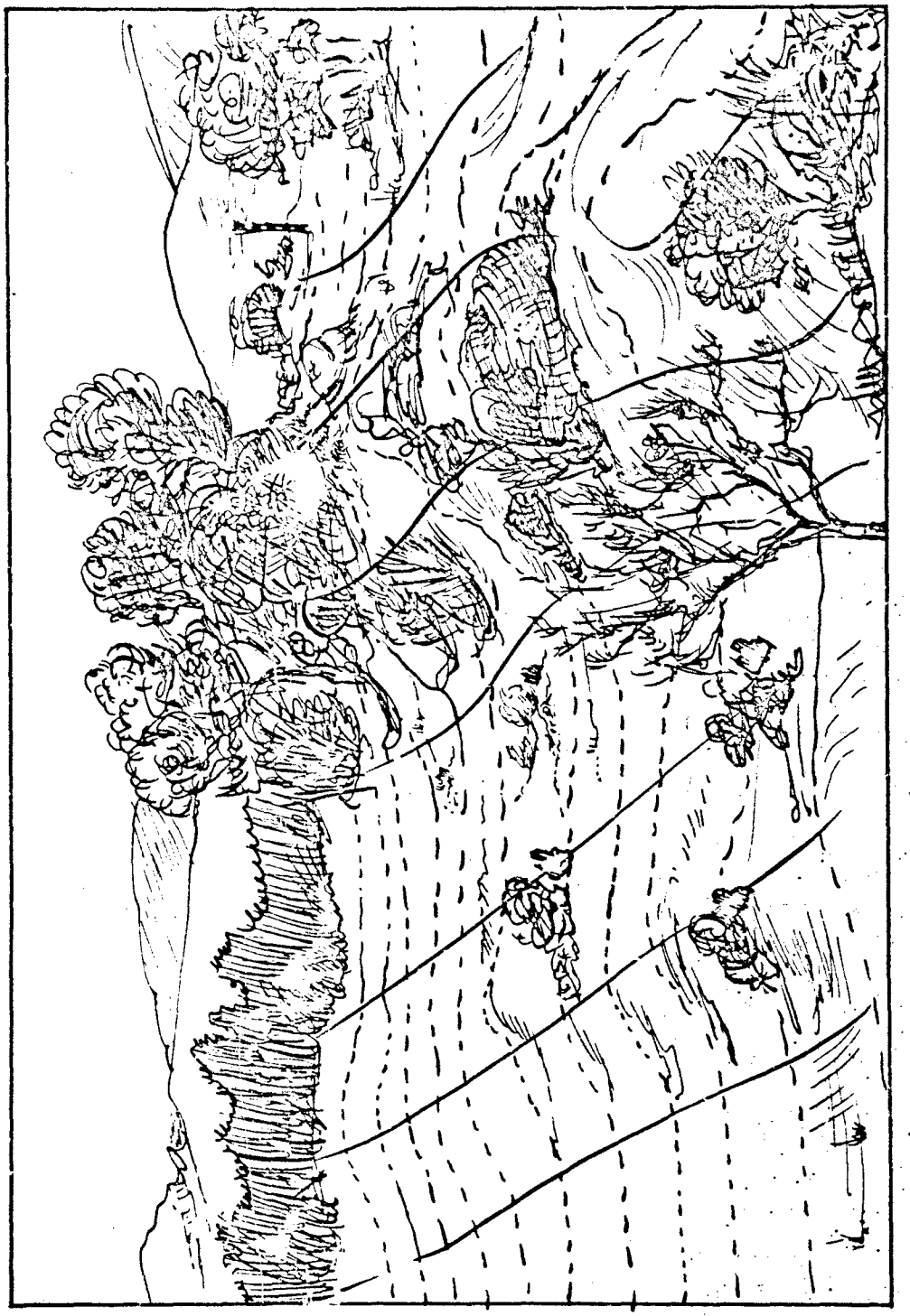

FIGURE 3

ATTACK RANGE NO. 1

FIGURE 4

TERRAIN, ATTACK RANGE NO. 1

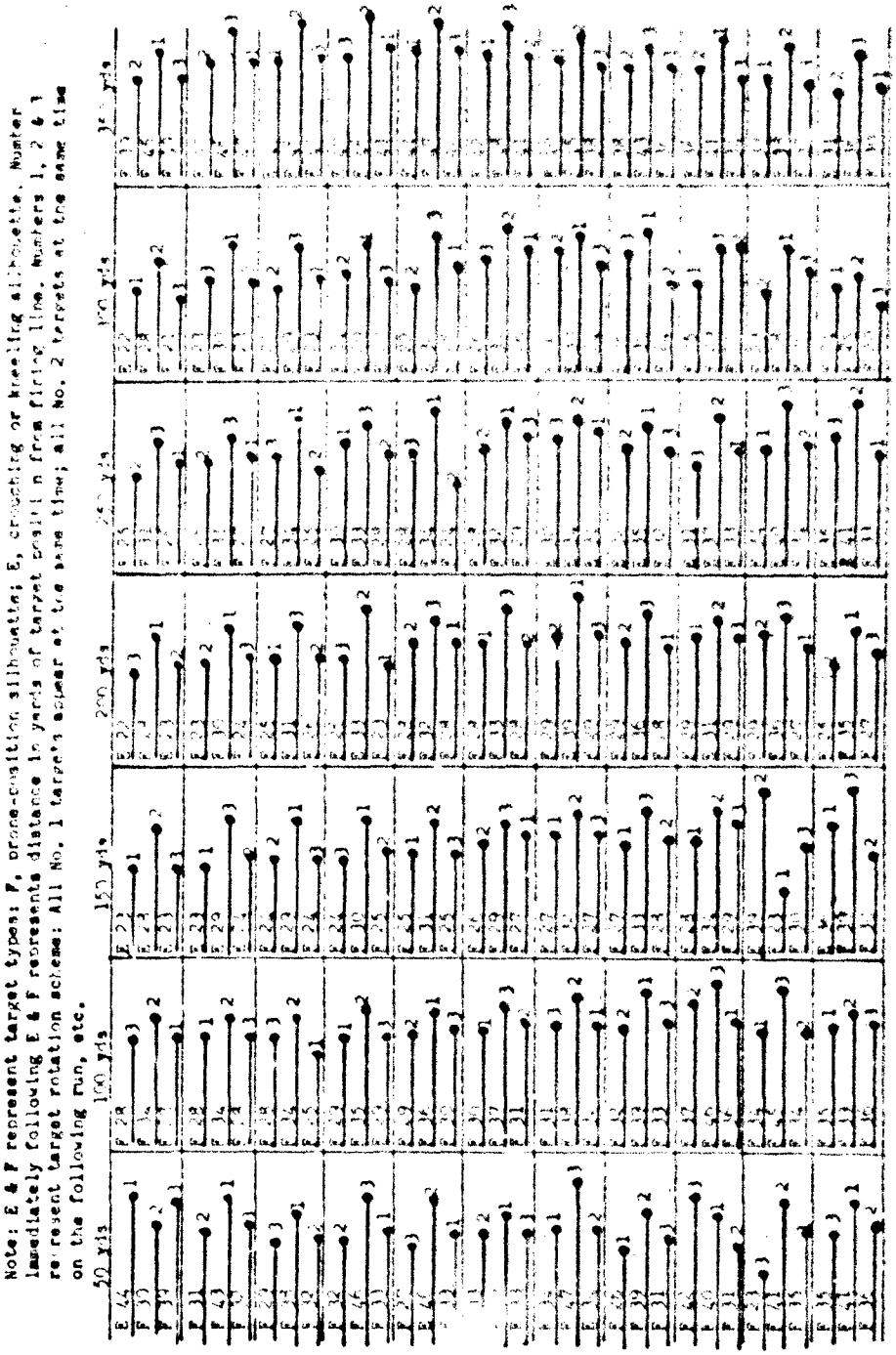

FIGURE 5
:T ROTATION SYSTEM, ATTACK RANGE NO. 1

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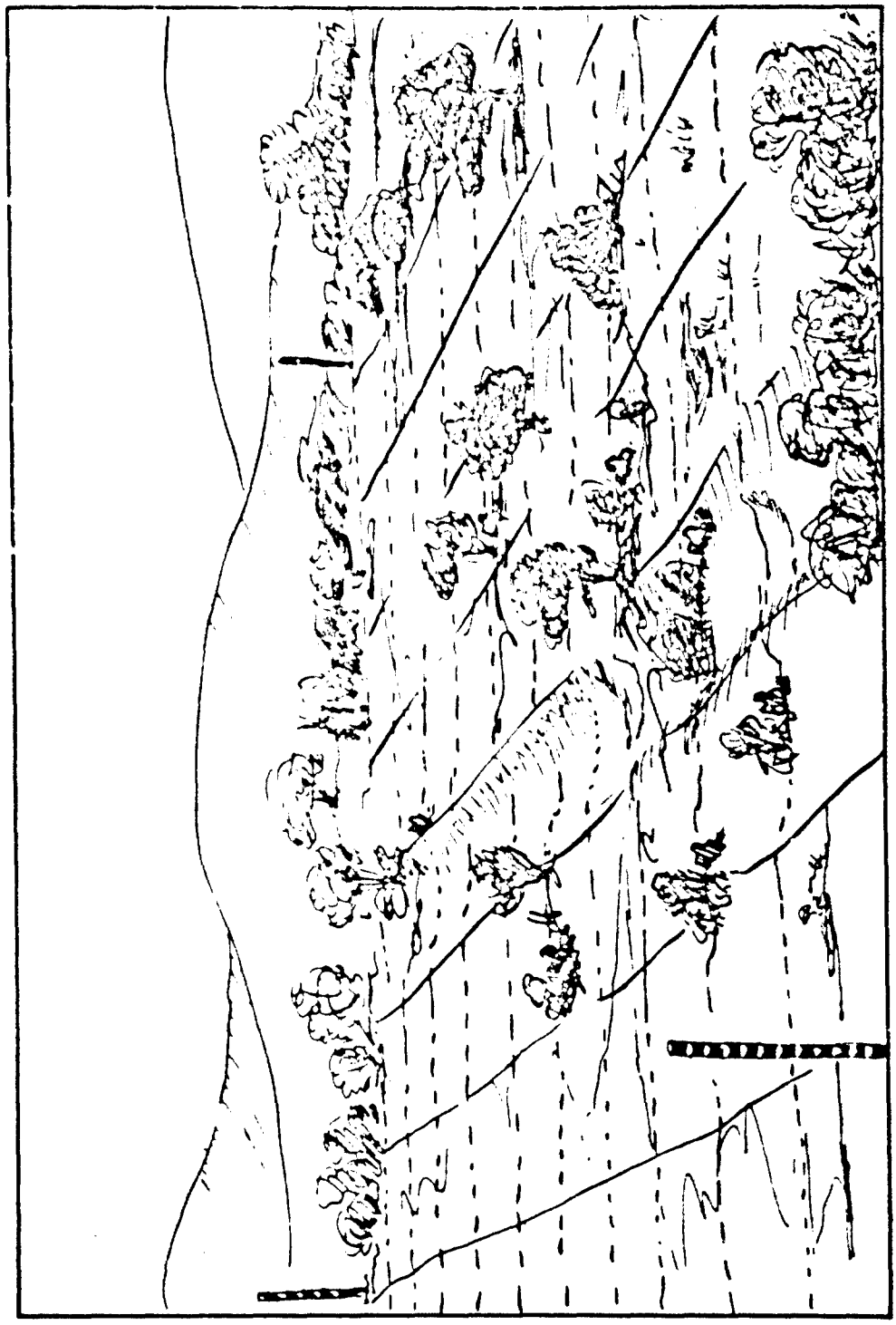

FIGURE 6
ATTACK RANGE NO. 2

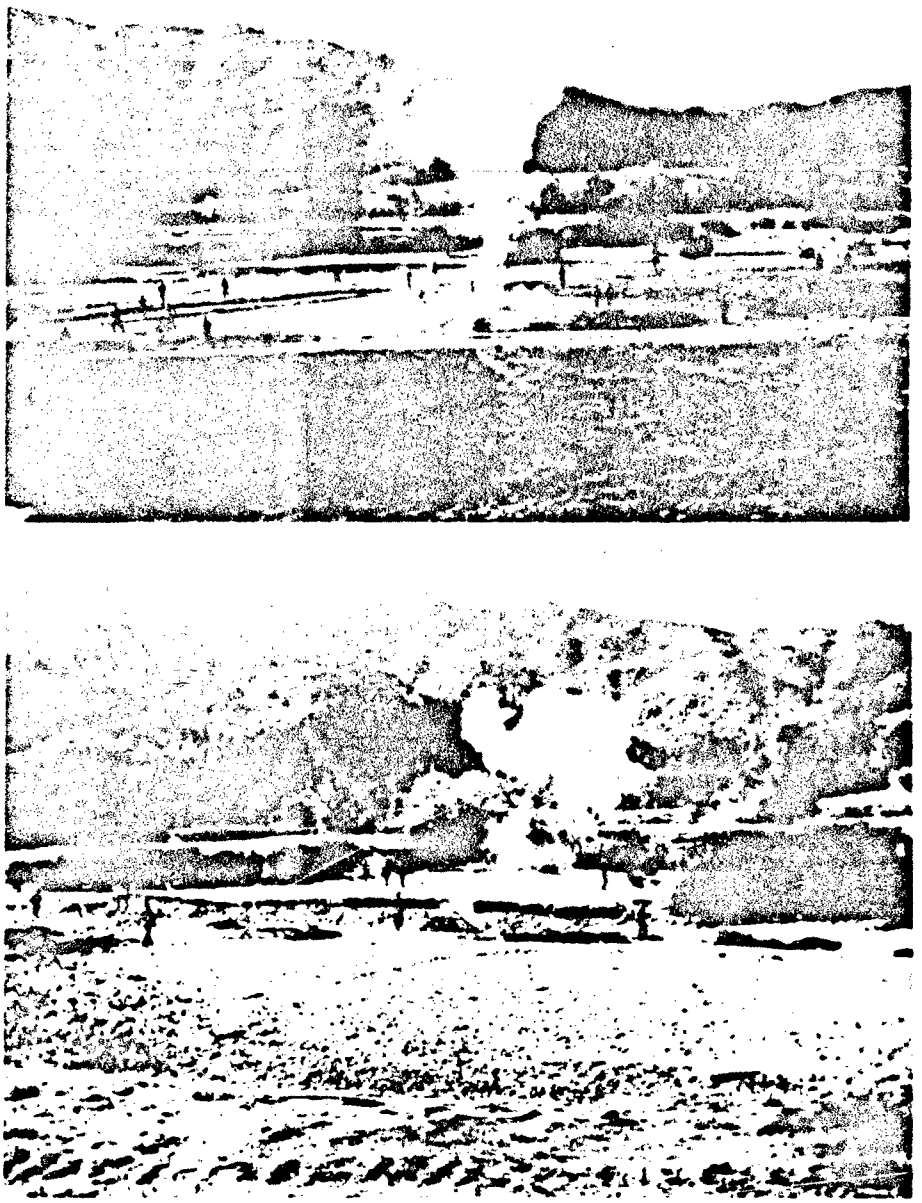

FIGURE 7

TERRAIN, ATTACK RANGE NO. 2

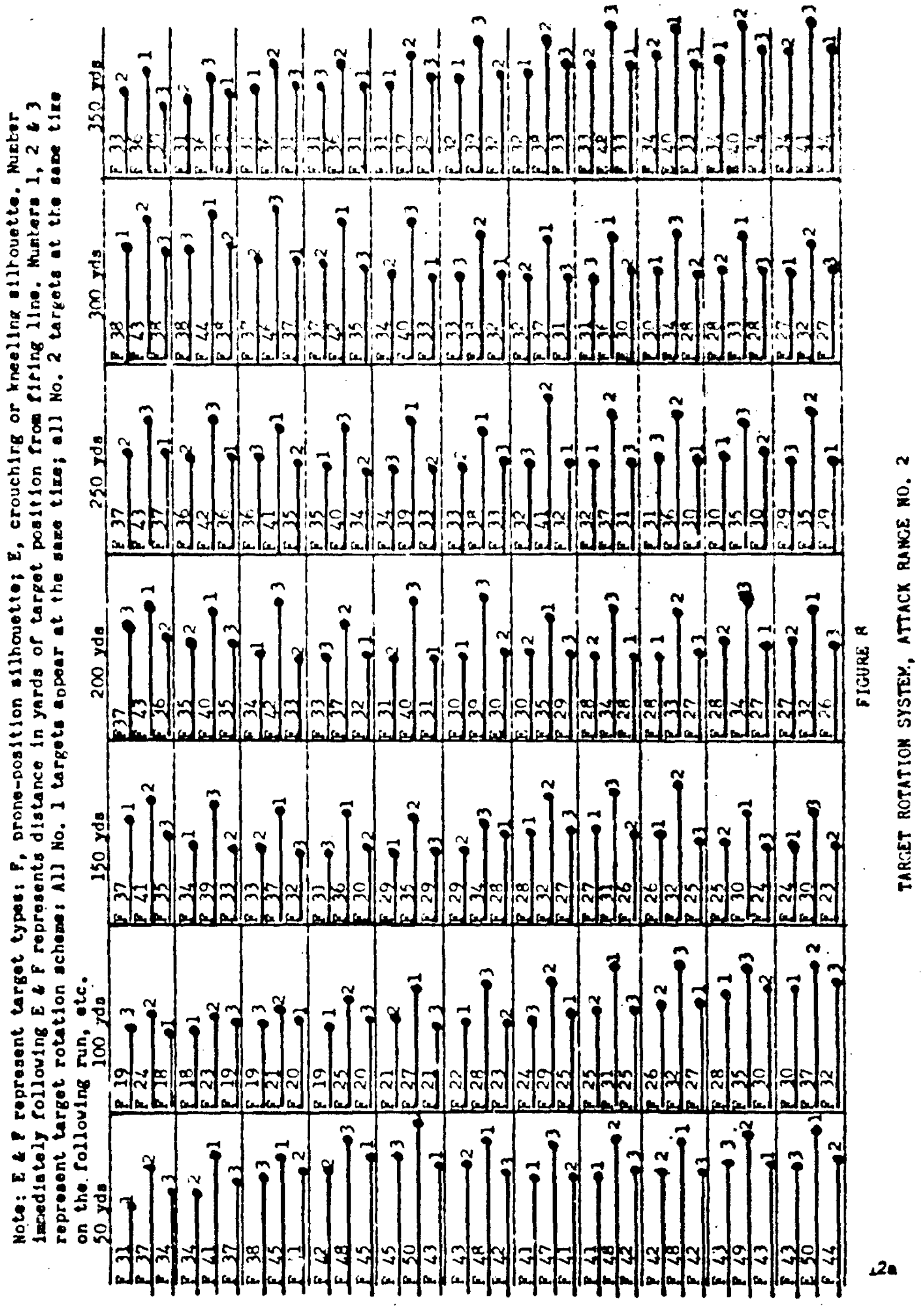

FIGURE 8
TARGET ROTATION SYSTEM, ATTACK RANGE NO. 2

FIGURE 9
DEFENSE RANGE

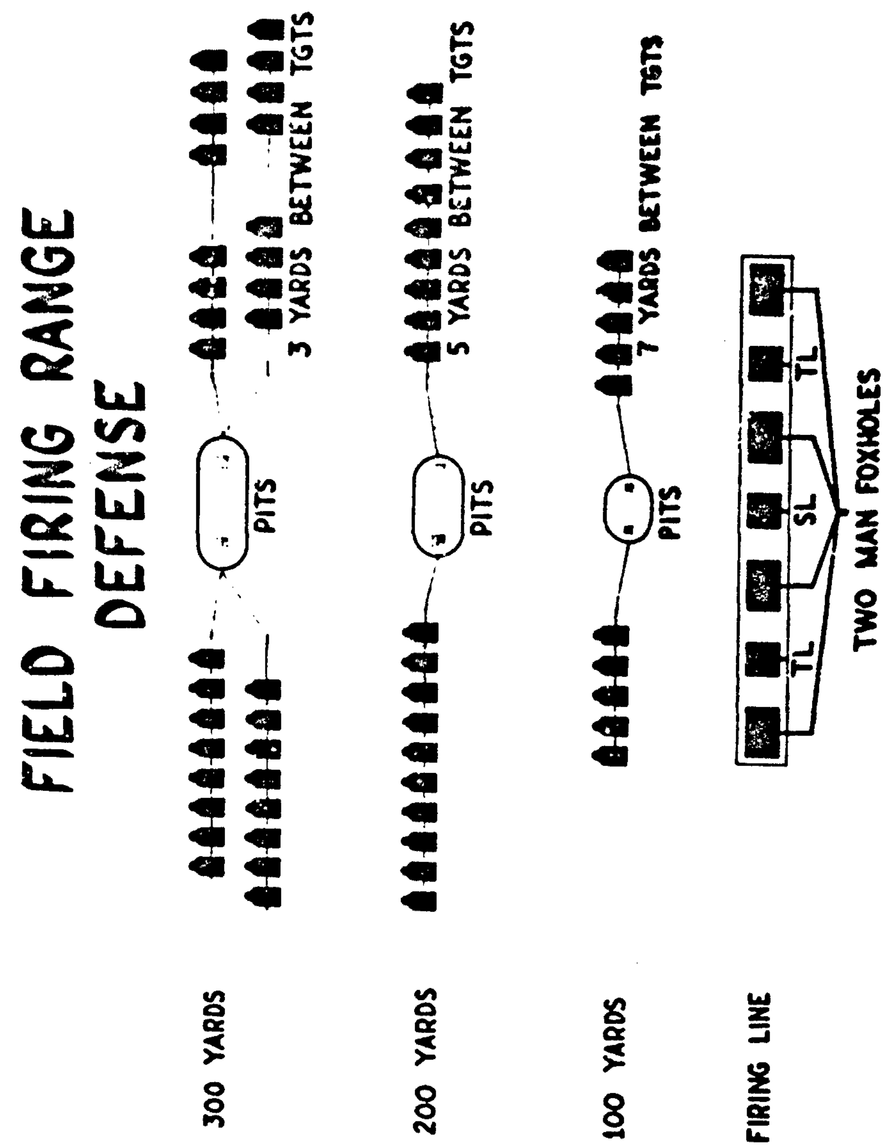

FIGURE 10

TARGET ARRAYS, DEFENSE RANGE

The appearance of targets first at the 300-yard range, next at the 200-yard range, and finally at 100 yards, simulated the advance of enemy troops upon the defensive position (the firing line). The decrease in the number of targets appearing at each successively closer range similarly represented attrition of the advancing enemy force. For details of target presentation sequence see Annex A.

For night defense operations a small red light, mounted on a stake in front of each target, was flashed at irregular intervals to simulate the appearance of enemy rifle fire at night. The light system was activated by personnel located in the control pits. The sequences of target appearance were same as in daylight defense operations. However, during night operations, in the absence of artificial illumination, only the flashing red lights simulating muzzle flashes could be seen from the firing line. At night targets were in view 25 to 35 percent longer than during daylight operations.

4. EXPERIMENTAL FORCES

a. Proficiency Testing

Before the Lightweight High-Velocity Rifle experiment commenced, 75 riflemen scheduled to take part in the experiment accomplished a conventional transition firing course. The object was to sort these men into relative proficiency categories in order to investigate the effect of skill on weapons performance. Only the Armalite AR-15 and the M-14 were used in the transition course, as the Winchester lightweight rifle was not available at that time.

Firing data were used to calculate proficiency scales, and the 75 riflemen were divided into three platoons of 25 men each, based on relative proficiency. The highest proficiency group was designated First Platoon; the median proficiency group, Second Platoon; and the lowest proficiency group, Third Platoon.

In order to increase familiarization with the three rifle types, riflemen fired on known-distance ranges in addition to transition courses.

b. Organization

(1) Attack Phase

In the attack phase, the 75-man experimentation force was divided according to relative proficiency into three firing platoons of 25 men each as described in paragraph 2, above.

Each platoon was first organized in 2 squads composed of 7 and 9 men, plus 9 supernumeraries, and alternately organized in 2 squads composed of 5 and 11 men, plus 9 supernumeraries (Figure 11).

On any given day of the attack experimentation program, one of the three platoons, organized into the various squad sizes, was used for all runs. For the detailed schedule of experimentation force employment see Experiment Designs, Annex A.

(2) Defense Phase

In the day and night defense phases, 60 of the experimentation troops were employed. This force was divided according to relative proficiency into two firing platoons of 30 men each. Each platoon was first organized in 2 squads composed of 11 and 5 men, plus 14 supernumeraries, and alternately organized in 2 squads composed of 9 and 7 men, plus 14 supernumeraries (Figure 12).

On any given day of the defense program, one of the two platoons, organized into the various squad sizes, was used for the runs scheduled for a half-day's experimentation. The other platoon was employed during the second half-day. For the detailed schedule of experimentation force employment, see Experiment Designs, Annex A.

5. WEAPONS

a. Introduction

Three types of rifles were employed in this experiment: the US Rifle M14 caliber .30 (7.62mm), the Winchester Lightweight Military Rifle caliber .224, and the Armalite AR-15 Rifle caliber .222.

In 1956 the US Army Infantry Board at Fort Benning, Georgia, tested the T-44, US version of the Belgian Fabrique Nationale rifle, against the standard US Rifle, M-1, caliber .30. As a result of these tests the T-44, redesignated M-14, was adopted as the US standard rifle. It was chambered to fire the 7.62mm NATO round. Since the adoption of the M-14, American industry has continued a weapon research program, the objective of which is to develop a lighter, more rugged, less complex, more accurate rifle for the Army of the future. The Olin-Matheison Cehemical Corporation developed the Winchester Lightweight Military Rifle caliber .224. Fairchild Aircraft and Engineering

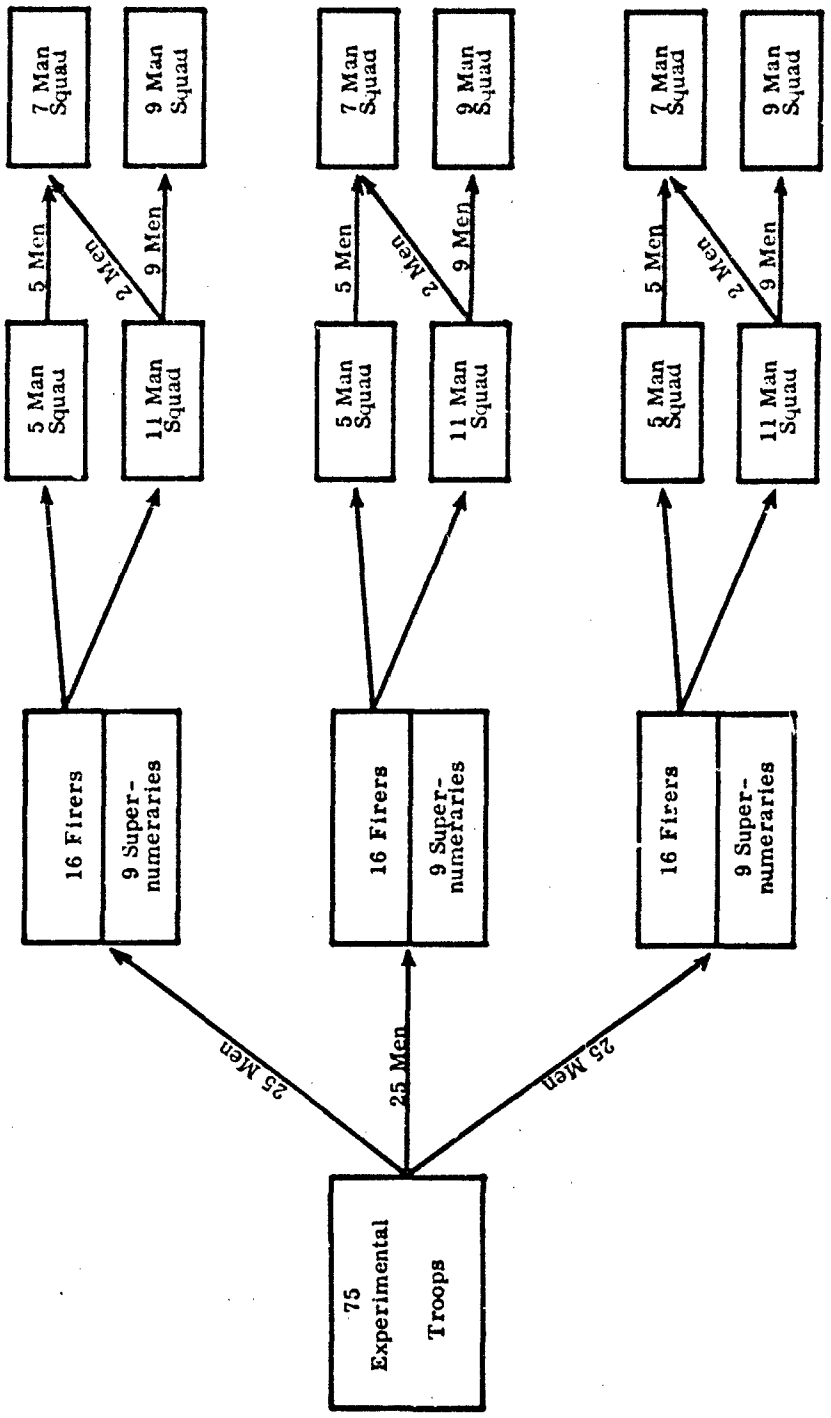

FIGURE 11
EXPERIMENTAL SQUAD ORGANIZATION
ATTACK PHASE

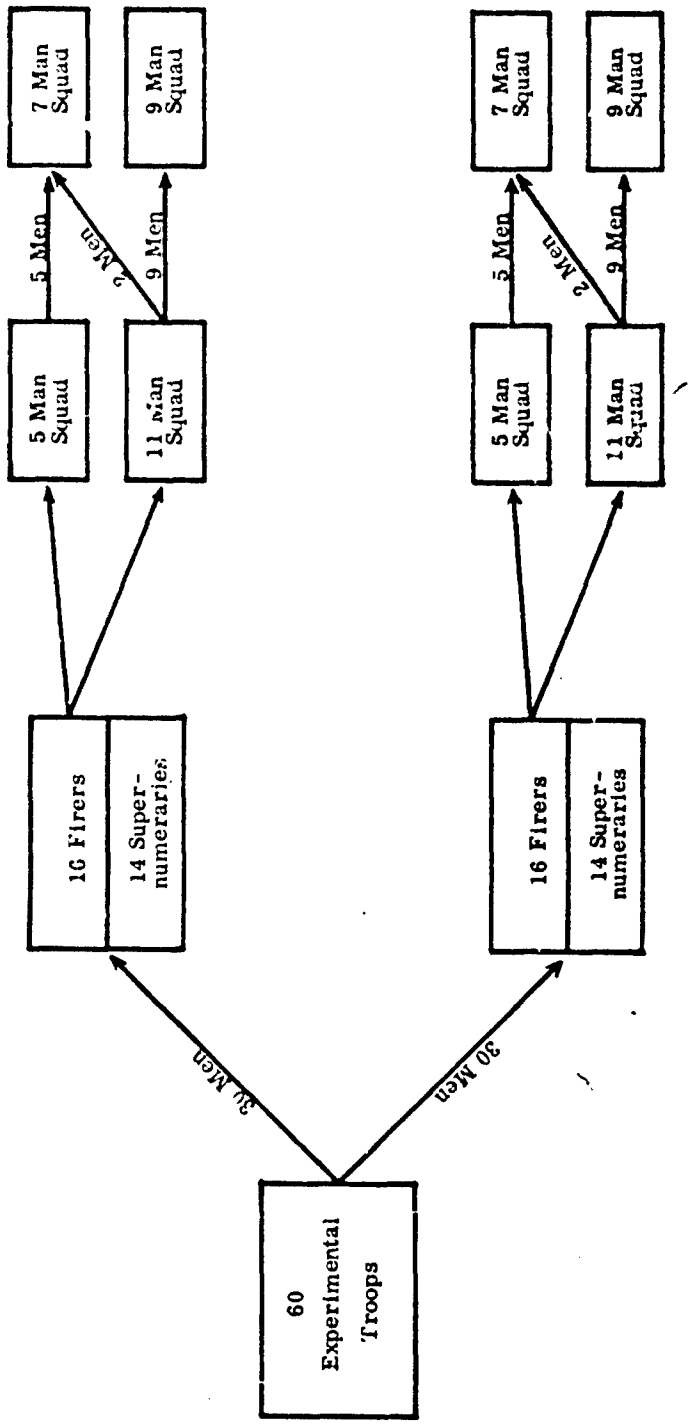

FIGURE 12
EXPERIMENTAL SQUAD ORGANIZATION
DEFENSE PHASE

Corporation has developed the Armalite AR-15 rifle caliber .222.

b. M-14

The M-14 is a 7.62mm, magazine-fed, gas-operated, shoulder-type weapon. It has an adjustable rear peep sight graduated in meters and a blade-type front sight. It is capable of both semi-automatic and automatic fire (Figure 13).

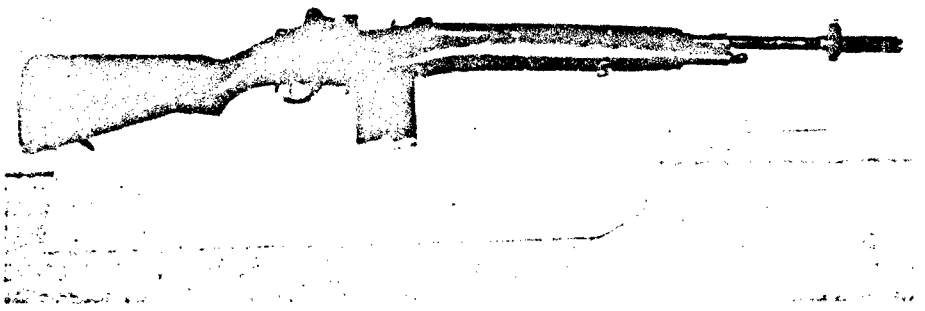

FIGURE 13, M-14 RIFLE

c. Winchester

The Winchester Lightweight Military Rifle caliber .224 is a magazine-fed, gas-operated, shoulder-type weapon. The rifle is equipped with a blade-type front sight and a two-position flipover rear sight mounted on the back of the receiver — the low setting adjusted for 250 yards and the high setting for 440 yards. Among the unique features of this rifle is the short stroke piston of the gas system which requires no cleaning or disassembly during the life of the gun. Also, parts not subject to extreme stress, such as the trigger housing, are made of aluminum. The rifle is capable of both semi-automatic and automatic fire (Figure 14).

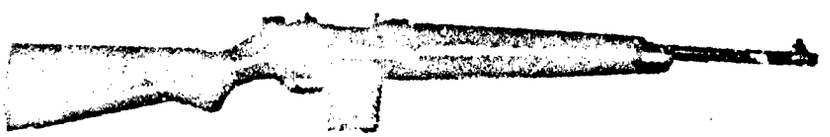

FIGURE 14, WINCHESTER RIFLE

d. Armalite AR-15

The Armalite AR-15 rifle, caliber .222, is a magazine-fed, gas-operated, shoulder-type weapon. The rifle is equipped with a tapered-post type front sight which can be adjusted for elevation, and a two-position, flipover rear peep sight mounted in the carrying handle. The rear sight is set for 100 yards and 300 yards and can be adjusted for windage only. Among the unique features of the rifle are fiberglass construction of stock and handguard, and an unusual straightline design of the weapon from the muzzle through to the heel of the butt-stock. The rifle contains only nine moving parts. It can be fired on semi-automatic and on full automatic (Figure 15).

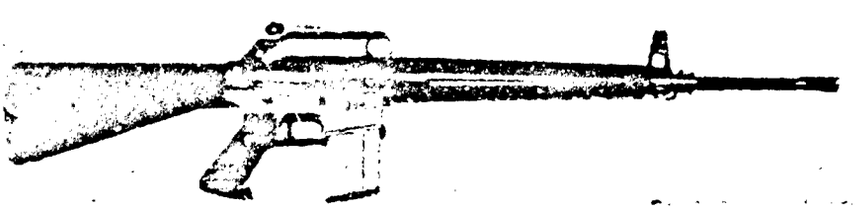

FIGURE 15, ARMALITE RIFLE

e. Weapon Characteristics

A tabular comparison of the key characteristics of the three rifles used in the experiment follows:

	M-14	Winchester	Armalite
Weight of unloaded rifle	8.2 lb.	4.9 lb.	5.3 lb.
Weight of fully loaded rifle	10.0 lb.	5.5 lb.	6.1 lb.
Caliber	.30 in.	.224 in.	.222 in.
Overall length	*44.19 in.	37.6 in.	*37.5 in.
Length of barrel	22.0 in.	20.0 in.	20.0 in.
Muzzle velocity	2800 ft./sec.	3300 ft./sec.	3300 ft./sec.
Maximum cyclic rate	750 rds./min.	750 rds./min.	750 rds./min.
Cartridge	7.62mm M-59 (NATO)	.224	.222
Magazine capacity	20 rds.	20 rds.	25 rds.
Effective range	700 yds.	500 yds.	200 yds.
Sight radius (at 100 yds.)	26.75 in.	23.2 in.	18.25 in.
Number of parts	94	71	34

* With flash suppressor

6. DATA COLLECTION SYSTEM

a. Data Recording - Attack Phase

In the attack phase, data gathering was accomplished by data collectors who accompanied each rifleman through the course (Figure 16). The following key items of information were recorded: number of shots fired on each firing line during the 5-second firing period; number of shots fired after the suspend-fire whistle; and all misfires, stoppages, breakdowns or other unusual occurrences. At the end of each run the controller officer examined the data sheets for errors or omissions and the data sheets were then given to the data analysts in the rear area to be collated, compiled and charted. (See Annex B, Data Forms.)

FIGURE 16

DATA RECORDER AND RIFLEMAN, ATTACK RANGE

b. Hit Counting - Attack Phase

Following each wave of riflemen and data collectors

on the course, hit counters examined each target, counted bullet holes, and recorded the total numbers of hits, along with the appropriate target numbers. Each bullet hole on a target was marked and the run number recorded (Figure 17). When targets became excessively perforated the hit counters replaced them. The hit counters were also responsible for shifting targets to alternate positions in accordance with the design of the experiment.

FIGURE 17

HIT COUNTER AND TARGET ATTACK RANGE

c. Data Recording - Defense Phase

Data gathering in the defense phase was accomplished by data collectors who were located behind each rifleman (Figure 18). The following key items of information were recorded: number

of rounds fired at each target line (100, 200, and 300 yards); and all stoppages, misfires, breakdowns, or other unusual occurences. During automatic-fire runs the number of shots fired was not counted directly. At the completion of the run, the remaining rounds of ammunition were counted and recorded by the data collector. The data sheets were then given to the data analysts in the rear area to be checked for errors and omissions and compiled. (See Annex B, Data Forms.)

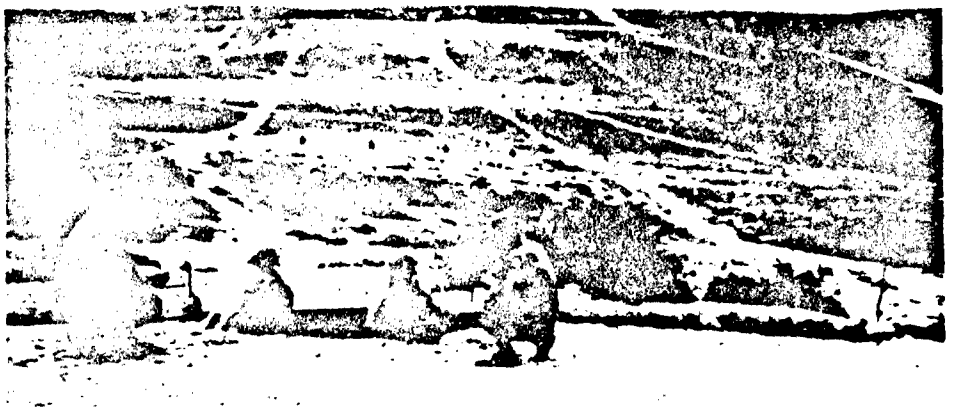

FIGURE 18

DATA RECORDERS AND RIFLEMEN, DEFENSE RANGE

d. Hit Counting - Defense Phase

The number of bullet holes on a target was scored in two ways; instrument count and manual count. The first hit count was accomplished automatically at the time of impact by Esterline-Angus event recorders (Figure 19). Operations of the event recorders were as follows:

Silhouette targets were constructed of aluminum and each was equipped with three micro-switches for sensing target hits. The three micro-switches on each target were connected in series to one channel of an Esterline-Angus pen event recorder. Shock waves generated by the impact of bullets caused the micro-switches to open. This action interrupted current flowing through the recorder causing displacement of one of the recorder's constantly-moving graph paper. The data on the graph paper indicated not only which target was hit and how often, but also the exact time

the target was hit as measured from the time of initial target exposure.

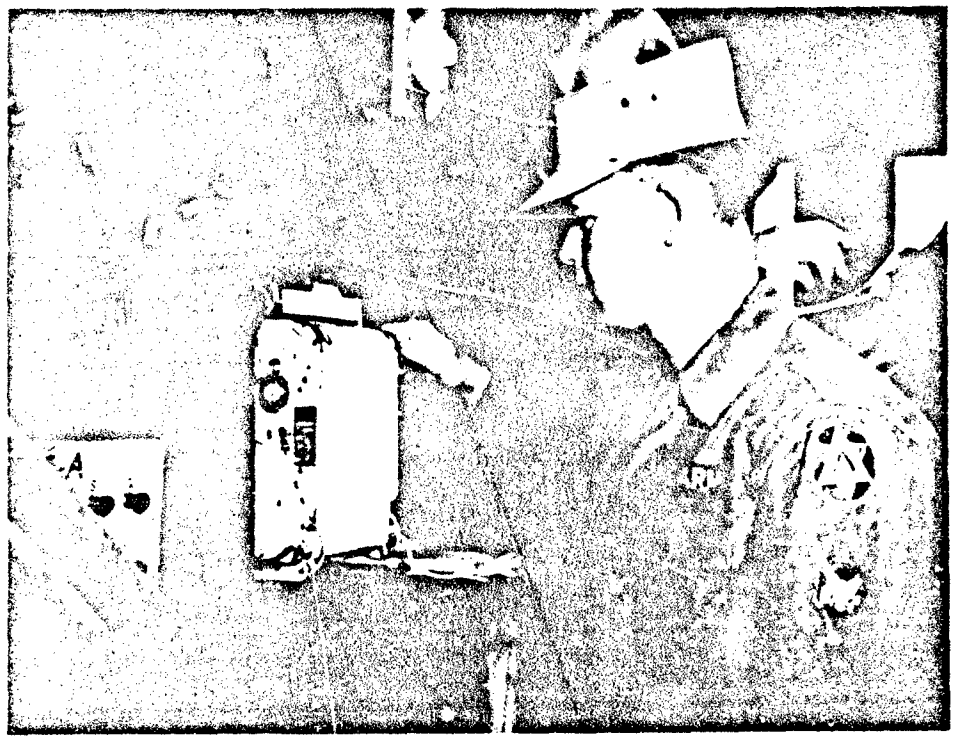

FIGURE 19

ESTERLINE-ANGUS EVENT RECORDER
DEFENSE RANGE PIT

A second or confirming hit count was made by men from the target control pits who, between runs, manually counted the bullet holes in each target (Figure 20). This action was advisable as a cross-check, and probably produced more accurate information than th[illegible] recorders in view of substantial instrument error. Instrument inaccuracies were caused by such factors as recording as hits the impact of sand or dirt fragments kicked up by near misses, recording only one hit when more than one bullet struck a target at the same time, and breakdowns in the microswitches or their circuits.

FIGURE 20

HIT COUNTER AND TARGET,
DEFENSE RANGE

After each firing run, hit scores from the event recorders and manual count were compiled and transmitted by phone to the range control tower (Figure 21). Esterline-Angus graphs and hit count sheets were collected for subsequent analysis and graphs and data sheets for the following runs were marked with appropriate identifying information.

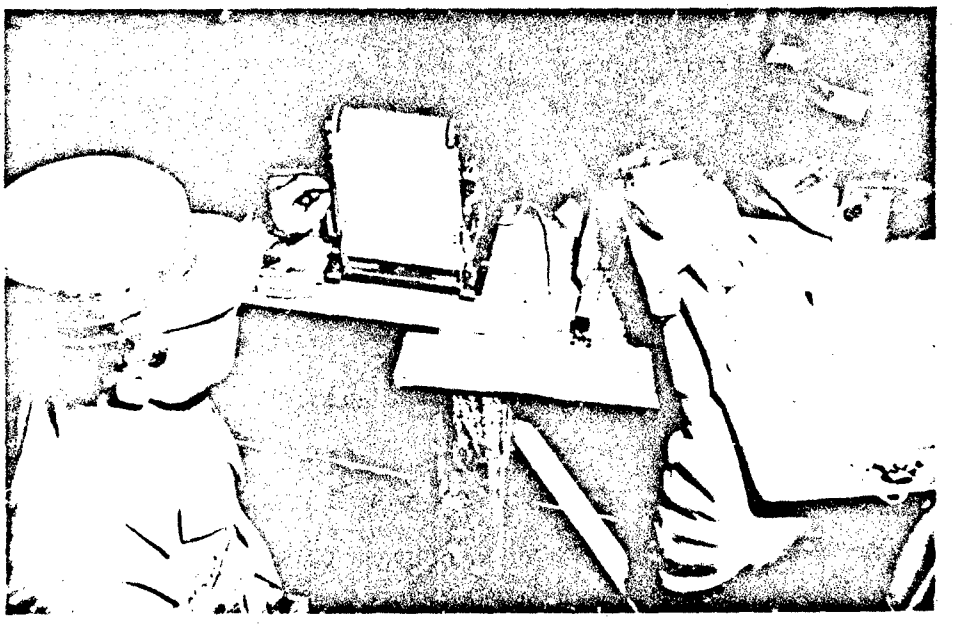

FIGURE 21

TARGET HIT COUNT TRANSMITTED
TO CONTROL TOWER

7. TYPICAL EXPERIMENTATION RUNS

a. Introduction

Because of the repetitive nature of the Lightweight High-Velocity Rifle experimentation runs, the conduct of the experiment may best be illustrated by typical examples of experimentation runs on attack and defense ranges. Detailed sequential accounts of the relevant actions that took place during each run are as follows:

b. Experimentation Run - Attack Range

Following is a detailed description in chronological order of a typical experimentation run, 11-man squad armed with M-14 as performed on attack range:

(1) Squad size and weapon type as scheduled in experiment design announced by data collector.

(2) Squad members names called off.

(3) Individually assigned rifles of the designated type drawn from ammunition rack by firers. Two partially loaded clips (30 rounds) of ammunition drawn by each firer.

(4) Each rifleman informed of his relative position on the course.

NOTE: Chief data collector insured throughout the daily series of runs that no firer was assigned the same relative position on the line.

(5) Data collector assigned to each rifleman. Preliminary information recorded on data sheets (name, rifle number, run number, relative position in the squad, weather conditions, etc.). (See Annex B.)

(6) Signal given from control tower to start run.

(7) Squad led forward 200 yards in squad column formation toward start line of the attack range.

(8) Signal for squad to deploy on start line given by range officer (artillery flash and sound simulator).

(9) Weapons loaded on start line, selector switches set on semi-automatic, safetys released.

(10) Position taken behind firers by data collectors.

(11) Signal to move forward given by control officer (whistle blast). (Figure 22.)

(12) First fire control line (marked by tape) reached by squad. A concerted effort was made by controllers to insure that every man was brought up on the line before firing commenced.

(13) Whistle blast signal to COMMENCE FIRE given by controller officer.

(14) Firing positions rapidly taken by squad (generally standing or kneeling position).

(15) Targets fired on by squad.

NOTE: Targets were located 20 to 50 yards from each firing line. All were

partially concealed, covered, or camouflaged. Eleven targets were distributed across the front of each of the seven firing lines, for a total of 77 targets on the range.

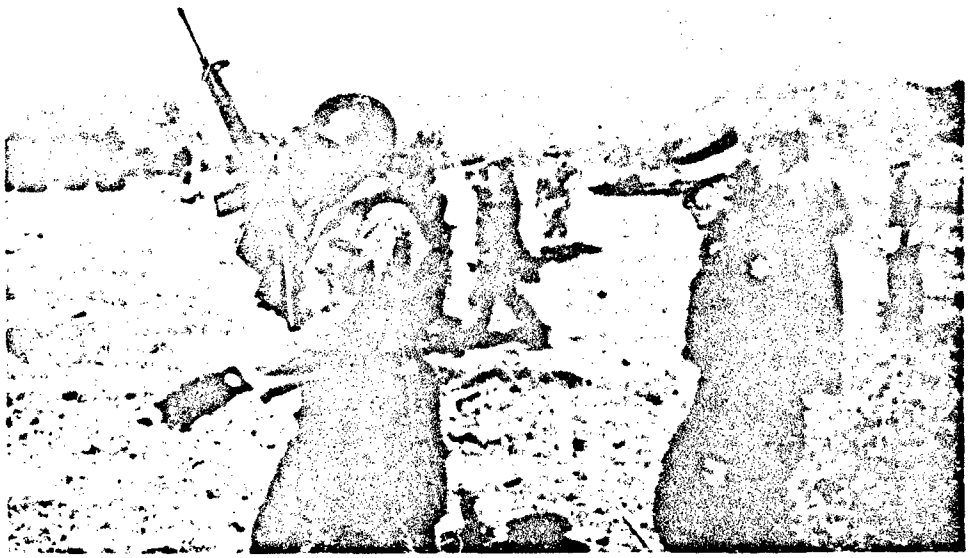

FIGURE 22

RIFLEMEN AND DATA COLLECTORS BEGIN A RUN, ATTACK RANGE NO. 2

(16) Squad permitted to fire for five seconds. (Timed by controller with a stopwatch).

(17) Whistle blast signal to SUSPEND FIRE - MOVE FORWARD given by controller officer.

(18) Movement of squad forward continued until next fire control line (50 yards between firing lines).

(19) Whistle blast signal to COMMENCE FIRE given by controller officer.

(20) Firing positions rapidly taken on second phase line. Firing on targets to front resumed by squad.

(21) At the end of five seconds, whistle blast signal to SUSPEND FIRE - MOVE FORWARD given by controller officer.

(22) Sequential procedure described above continued until the seventh (300 yd.) firing line reached.

NOTE: During the time that the squad member was firing, the data collector who was accompanying him recorded the number of shots fired at each line, the number of shots fired before the COMMENCE FIRE whistle or after the SUSPEND FIRE whistle, and any misfires, stoppages, breakdowns or other unusual occurrences, e.g., man broke his glasses, put ammunition clip in backwards, rifle fired full automatic, etc. Throughout the run, artillery flash and sound simulators were detonated at the rate of six per firing line. These simulators were noticeably effective in producing a psychological reaction; i.e., they tended to startle firers.

(23) At termination of firing on seventh line, command CEASE FIRE given by controller officer. Rifles set on SAFE by firers.

(24) Data collectors and squad members led to end of range. Rifles unloaded and remaining cartridges counted into ammunition boxes. Ammunition count verified and recorded by data collector.

(25) All rifles cleared by safety officer.

(26) Each data recorder form was checked by controller for errors or inconsistencies that could be corrected immediately after the run while the data recorder and the firer were teamed together on the range.

(27) Rifles turned in. Armorer informed by firers of any stoppages, breakdowns or other unusual occurrences. Data sheets turned in to data control table. Raw data compiled and charted.

NOTE: Average time length of run: 20 minutes.

(28) Number of bullet holes in each target recorded by hit counters moving one phase behind the attacking squad. Bullet holes marked and identified according to the number of the particular run. Target shifted in accordance with design and replaced when necessary.

NOTE: The target layout and the conduct of a run were similar for each range except that Attack Range I was hilly and Attack Range II was flat.

In the attack phase of the experiment the squad leader participated in the firing as a rifleman, rather than as a leader. Safety factors and precautions against confounding the data precluded any maneuvering, movement by infiltration, or other tactical schemes.

c. Experimentation Run - Defense Range

Following is a detailed description in chronological order of a typical experimentation run as performed on the defense range.

(1) Data recorders briefed on coming run. Data sheets prepared.

(2) Scheduled squad size, weapon type and fire technique announced by data collector; e.g., 5-man squad - Armalite - semi-automatic at 300 and 200 - automatic at 100; 11-man squad - M-14 - two on full automatic, eight on semi-automatic.

(3) Squad members names called off.

(4) Individually assigned rifles of appropriate type drawn by firers from arms rack.

(5) Squad guided to firing line and each man directed to proper foxholes by data collector. Final briefing given to each firer on any special detail of the coming run; e.g., when to change from full automatic to semi-automatic, or which men will fire full automatic while the rest fire semi-automatic.

NOTE: In the defense runs the squad leader did not take part in the

firing but acted in the leader role, standing in the middle of the firing line and directing the attention of the squad to the enemy formations (target arrays) that appeared to the front.

(6) Position taken behind firers by data collectors, one for each firer. Firers' names recorded.

NOTE: Information gathered by data collectors during course of run included misfires, stoppages, breakdowns, any unusual occurrences; e.g., rifle became too hot to handle; in 2-man foxhole, hot shell cases from rifleman on left struck rifleman to the right in face, etc.

(7) Ammunition distributed: 140 rounds to men designated to fire full automatic; 40 rounds to men designated to fire semi-automatic; 80 rounds to men designated to fire full automatic with limited ammunition supply.

(8) Command "LOAD AND LOCK" given from tower by range officer.

(9) Riflemen alerted by squad leader to watch for appearance of enemy (targets).

NOTE: Target controllers in the pits were alerted and directed to raise and lower the various target arrays by instructions from the control tower. The instructions were tape recorded and transmitted to pits by a separate public address system.

(10) Array of eight targets on right half of line sighted at 300-yard range (targets up 10 seconds)

(11) Command "THREE HUNDRED RIGHT" given by squad leader (Figure 23).

FIGURE 23

SQUAD LEADER GIVES COMMAND TO RIFLEMEN

(12) Targets fired on by squad.

(13) Targets down.

NOTE: Three additional target arrays appeared at 300 yards for an average time of 11 seconds each. Following this, four target arrays appeared at 200 yards for an average time of 7 seconds each. Finally three target arrays appeared at 100 yards for an average time of 5 seconds each. To prevent learning and for tactical realism irregular intervals of 10 to 30 seconds were scheduled between target presentation and the sector appearance was also varied irregularly.

The terminal target presentation of a run was as follows:

(14) Target array of ten targets sighted at 100-yard range. (Targets up 4 seconds.)

(15) Command "FIRE" given by squad leader.

(16) Targets fired on by squad.

NOTE: Because of proximity to firing line, the location of targets at the 100-yard range was not given by the squad leader. Squad fired at 100-yard targets immediately upon command.

(17) Targets down.

(18) Command "CEASE FIRE, CLEAR AND LOCK ALL WEAPONS" given by range officer.

(19) All weapons on line cleared by Safety Officer.

(20) Amount of ammunition remaining for each firer recorded by data collectors.

(21) Departure from line completed by squad.

(22) Pits informed range is clear.

(23) Targets examined and bullet holes counted by hit recorder personnel from the pits; target devices repaired; targets replaced if necessary; tower notified of scores.

(24) Data sheets turned in by data recorders to chief collector; sheets checked for errors.

NOTE: The average time length of a run was ten minutes. During night runs the target arrays remained up for a 30 percent longer period.

SECTION III

RESULTS OF EXPERIMENTATION

1. ANALYSIS

a. Introduction

(1) The objective of this experiment was to investigate the performance of a rifle squad as influenced by squad size and by rifle type in both offensive and defensive situations. In addition to the two independent variables - squad size and rifle type - hereafter designated as prime independent variables, other independent variables are considered. These will be designated as secondary independent variables, and include the following: proficiency of the firers constituting a squad, weather conditions, course traversed, and learning. Experimentation revealed that of these secondary independent variables, only the proficiency of the firers constituting a squad is worthy of more than passing comment in this analysis.

(a) The weather remained remarkably moderate and uniform throughout the course of the experiment. It was accordingly discarded as an independent variable. No further data are presented in this report, either to document the uniformity of weather conditions or to demonstrate the effect of weather on the data collected.

(b) The effects of the two secondary independent variables - course over which the attack situation was run and learning - have been accounted for in the experiment by using two different attack courses and having two replications on each course. The results of these four attack situations have been combined to yield the data that are subsequently analyzed.

1. In Figure 24 are shown the number of different targets hit, as ordinate, versus attack course number and replication, as abscissa. (It will be recalled that Course No. 1 was run first, followed by Course No. 2. Then followed a repetition of Course No. 1 and subsequently a repetition of Course No. 2 so that the abscissas of Figure 24 are arranged chronologically.)

2. From Figure 24 it appears that the troops did indeed learn to handle their rifles better in the attack situation as their experience increased.

(2) As stated in paragraph 1a above, it was the object of this experiment to investigate the performance of a rifle squad as a function of certain independent variables which were there named. It next becomes necessary to define the words "performance of a rifle squad", i.e., the dependent variable, in terms of a measurable quantity. It is possible to set forth a large number of such measurable quantities but the significance of many of them in measuring the performance of a squad is debatable.

(a) Should one wish to consider hits per pound of ammunition as a dependent variable, he will easily obtain this number from the following data: With the presently planned battle load of 22.39 lbs., the firer would carry 650 rounds of the lightweight high-velocity ammunition or 220 rounds of M-14 ammunition. (See Section III, Part 2, Logistical Impact and Section III, Part 4, Military Evaluation.)

(b) It has been deemed for the purposes of this experiment that the significant dependent variables are two, namely, the ratio of the number of hits to the number of rounds fired, and the ratio of the number of different targets hit to the number of hits. The former dependent variable will be called "hit probability"; the second dependent variable will be called "hit distribution". (In this definition, "distribution" is to be construed in the general, rather than statistical, sense.)

(3) In addition to investigating the dependence of squad performance on the selected independent variables in attack and defense situations in daylight, the scope of the investigation was extended to include a defensive night situation and the use of the fully automatic capability of the Armalite rifle.

b. Discussion

(1) This section then reports on the dependent variables - hit probability and hit distribution - as functions of the independent variables - squad size, rifle type, and firer proficiency, in situations of daylight attack, daylight defense, night defense, and defense using semi-automatic and fully automatic fire.

(2) Each of the two dependent variables shall be discussed as a function of the independent variables individually and as functions of the interactions between the independent variables. Comments on the various situations will be made where cogent.

(a) As shown in Table 1, the number of different targets hit, number of hits, and number of rounds fired increased

with increasing squad size in both the daylight attack and daylight defense situations; the first increasing asymptotically to the number of targets available, while the second and third tend to increase linearly with squad size. Whereas each of these three quantities is significantly different by the ordinary statistical tests, their ratios are not statistically different*. One concludes that neither hit probability nor hit distribution depends significantly on squad size.

(b) Table 2 shows number of different targets hit, number of hits, number of rounds expended, hit probability and hit distribution as functions of the three rifles for both the daylight attack and daylight defense situations. Here we find values which are significantly different by the ordinary statistical tests. We find also that the hit probabilities are significantly different for the Armalite rifle, being 0.357 as contrasted to 0.429 and 0.447 for the Winchester and M-14 rifles in the attack situation, and 0.223 for the Armalite as contrasted to 0.259 for either the Winchester or M-14 in the defense situation. On the other hand, the hit distribution for the Armalite rifle in the attack situation is 0.451 as contrasted with 0.426 for the Winchester and 0.432 for the M-14, while in the defense situation it is 0.432 for the Armalite contrasted with 0.427 and 0.414 for the Winchester and M-14, respectively. However, these latter differences are not statistically significant. One concludes then, that in hit probability the Armalite is inferior to the other two weapons in both attack and defense, and that in hit distribution in these situations, it cannot be said to be superior to the other two**.

(c) The dependence of hit probability and of hit distribution on squad proficiency is shown in Table 3. In this case, the attack and defense situations must be discussed independently since there were three proficiency levels in the former and only two in the latter. The number of different targets hit is not significantly different from a statistical point of view for the three proficiency groups in the attack phase. On the other hand, both the number of hits and the number of rounds expended were significantly different. It is interesting to note that the medium proficiency platoon fired almost the same number of rounds as the high proficiency platoon, but in

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* Throughout this report the level .05 was used as a basis for determining statistical significance.

** This inferiority of the Armalite rifle may be attributed to the poor sights as discussed in Section III, Part 4, Military Evaluation.

doing so, scored a much lower number of different targets hit (approximately 11% less). The lowest proficiency group fired wildly, expending approximately 11% more rounds than either of the two other, thereby scoring 6% more hits than the highest proficiency group. Their distribution of the fire was not as good, however, as that of the highest proficiency group in that they scored some 5% less different targets hit than the better platoon. However, on the basis of tests which have been applied to date, it cannot be stated that these differences in hit probability or in hit distribution for the three proficiency groups are statistically significant. In the defensive daylight situation, Table 3 reveals that the lower proficiency group, even with the expenditure of a somewhat larger number of rounds, scored fewer targets hit and fewer number of hits than did the higher proficiency group, although the latter group evidenced a higher hit probability while the former a higher hit distribution. Again, the differences are not statistically different.

(3) It becomes necessary next to discuss the variations of the dependent variables as functions of the interactions between the independent variables. With the three independent variables of squad size, rifle type, and proficiency, there will be three interactions; namely, squad size-rifle combinations, squad size-proficiency combinations, and rifle type-proficiency combinations.

(a) Table 4 shows the number of different targets hit, the number of hits, number of rounds expended, the hit probability, and the hit distribution as functions of both squad size and rifle type. We find again that the total number of rounds expended tended to increase in a somewhat linear fashion with squad size being statistically independent of rifle type. Moreover, regardless of squad size, the number of hits scored by the Armalite rifle was materially less in every case than that scored by either of the other two. The same condition holds true for the number of different targets hit.

(b) It is interesting to observe that in spite of the unreliability of the Winchester, which will be commented on at greater length subsequently, this rifle compared favorably with the M-14 both in the number of hits and in the number of different targets hit in each of the two daylight situations under consideration.

(c) A study of Table 4, then, reveals that in both attack and defense situations, the hit probability for the Armalite is appreciably lower than for either the Winchester or

M-14 which are generally comparable; whereas the hit distribution for the three rifles is not significantly different in a statistical sense, these conclusions being independent of squad size. When one multiplies the product of the hit probabilities of the table and the expected battle load of 650 rounds per man for the Winchester or the Armalite, or of 220 rounds per man for the M-14 by the number of firers, he obtains Table 4a which shows the number of hits expected tabulated by rifle for the various squad sizes in both the daylight attack and daylight defense situations. Column 4 of the same table, which is headed "Targets Expected" is obtained by dividing Column 2 of Table 4 by Column 4 of the same table to obtain the number of targets hit per round expended. This ratio then is multiplied by the total number of rounds available to the squad in the standard battle load to yield the entries in Column 4 of Table 4a. Table 4a shows clearly the fact that the squads armed with the lightweight rifles in either situation can be expected to obtain a greater number of hits or to hit a greater number of targets than squads armed with the M-14. For example, a five-man squad armed with the Winchester can expect a total of 1225 hits and 647 targets hit as contrasted with an eleven-man squad armed with the M-14 which can expect a total of 986 hits and 354 targets hit. (See Figures 25A - D.)

(d) Table 5 shows the same variables as have just been discussed, organized as functions of squad size-proficiency combinations for both the attack and daylight defense situations. This table tends to reveal little that is new. The less proficient squads, regardless of size, tended to expend more rounds, scoring thereby in half the cases tabulated a somewhat larger number of hits than the more proficient squads and in three of the eight cases tabulated a somewhat larger number of different targets hit than the more proficient squads. Generally, the hit probability and the hit distribution were both higher for the more proficient squads than they were for the less proficient squads, regardless of squad size.

(e) Table 6 shows the usual variables organized to display their dependence upon proficiency-rifle type combinations. Again this organization of the data reveals little that is new, but it does serve to emphasize the fact that, regardless of proficiency of the firer, the Armalite rifle has a lower hit probability than either of the other two rifles; while at the same time it tends to have a higher hit distribution than either of the

other two*.

(4) Table 7 summarizes the results of night firing. It will be observed that even though the targets were indicated by flashing lights to simulate their firing, the number of hits with no battlefield illumination was so low as to be without significance. Although performance improved appreciably when the battlefield was illuminated by flares, the number of hits scored was still less than 8% of the rounds fired.

(5) Table 8, which summarizes the significant conclusions of the investigation of technique of fire, is particularly interesting in view of the conclusion drawn by the opinion poll that the Armalite rifle on full automatic at 100 yards is to be preferred to either of the other rifles at this same range. The data presented compare the Armalite on fully automatic with the M-14 on semi-automatic at 100 yards. Under these conditions, we find that the Armalite, firing 819 rounds scored 71 hits on 27 different targets to obtain a hit probability of 0.087 and a hit distribution of 0.380. The M-14, fired semi-automatically, expended 235 rounds to score 127 hits on 31 targets, yielding a hit probability of 0.379 and a hit distribution of 0.244.

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* All data on daylight defensive firing were gathered as functions of range (100 yds, 200 yds, 300 yds). An analysis of rifle squad or squad performance by range reveals nothing that is germane to the objects of this experiment and hence is not reported here.

APPENDIX 1 TO SECTION III, PART 1, ANALYSIS

WEAPON FAILURE

Although weapon failure was not, and should not, be deemed an independent variable in this investigation in that the experiment was not designed to take it into cognizance, data on weapon failure were gathered during the daylight attack and defense phases of this experiment and are presented in Table 9 (A) and 9 (B) as a matter of record.

APPENDIX 2 TO SECTION III, PART 1, ANALYSIS

USE OF BIPODS

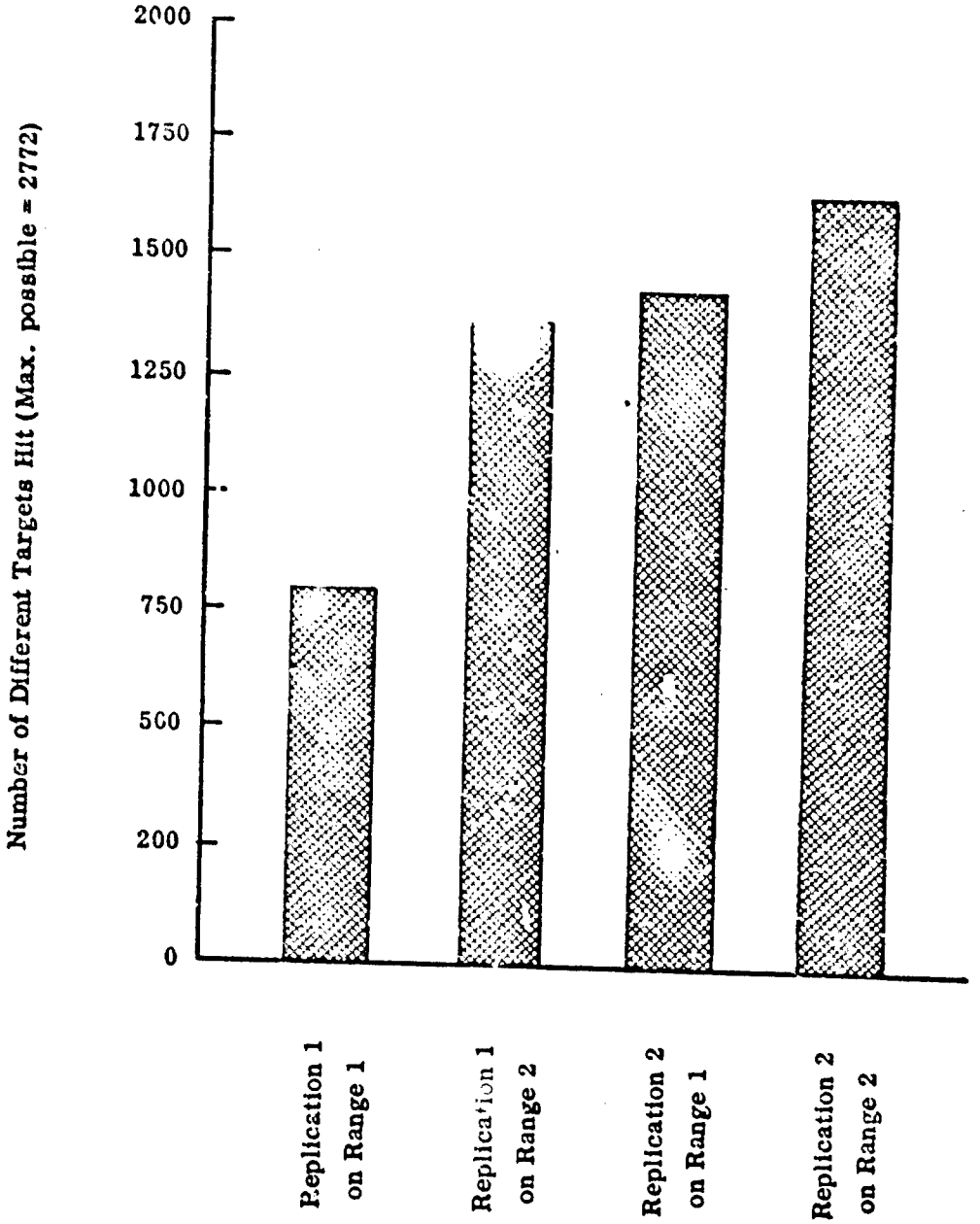
The use of bipods with both the Armalite and M-14 was given a cursory examination in the defense phase. Analysis of the statistical results indicated no measurable improvement in accuracy of the weapons when equipped with bipods.

APPENDIX 3 TO SECTION III, PART 1, ANALYSIS

USE OF TRACER AMMUNITION

The use of tracer ammunition with the M-14 was examined in the defense phase, at night under both non-illuminated and flare illuminated conditions, with the objective of investigating the value of tracer in improving hit capability. From examination of hit scores obtained at night with tracer, it would seem the effect, if any, on increasing hit capability was marginal.

Fig. 24 TARGETS HIT, PHASE I (ATTACK)



DAYLIGHT ATTACK

Fig. 25 A

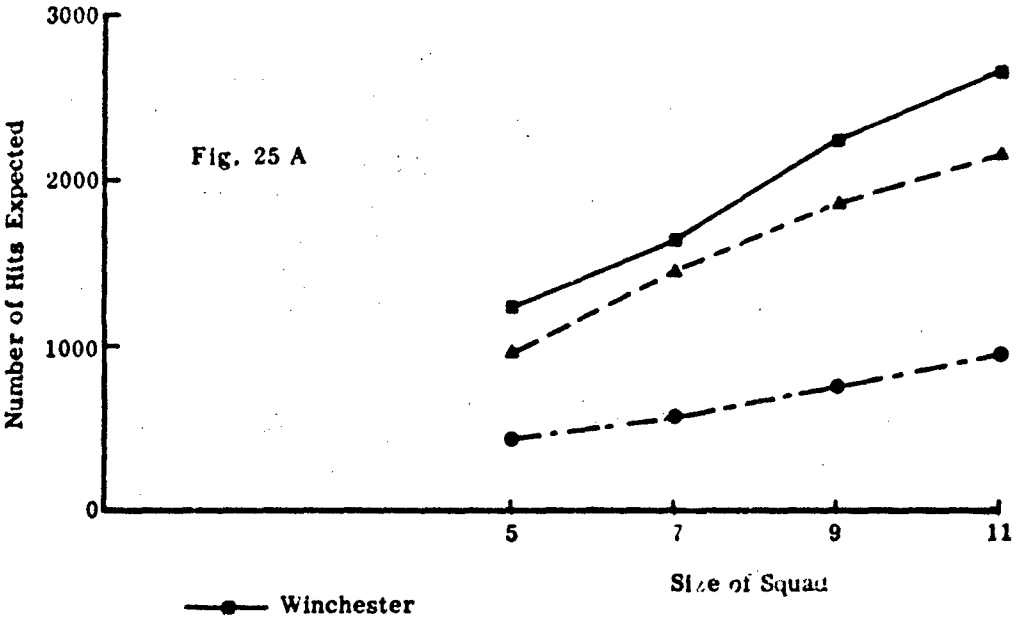
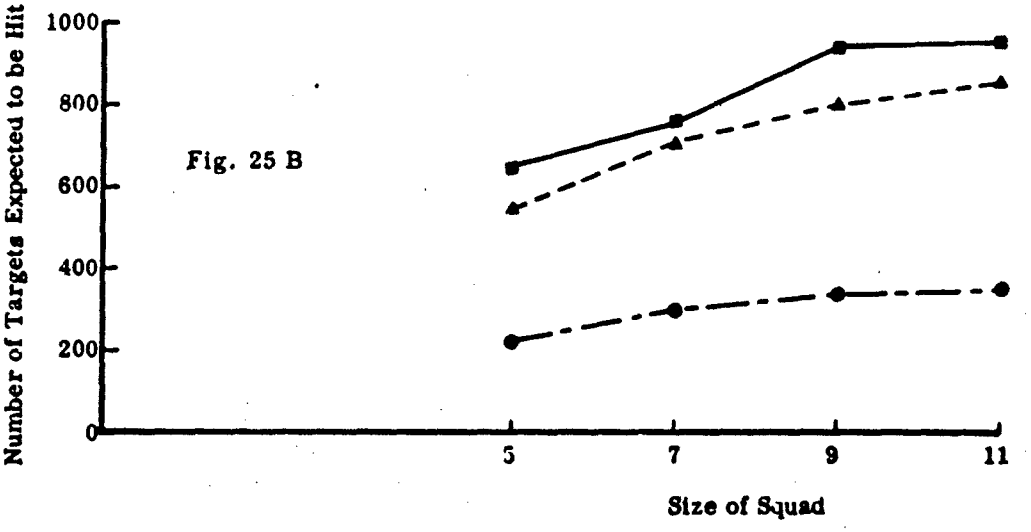


Fig. 25 B



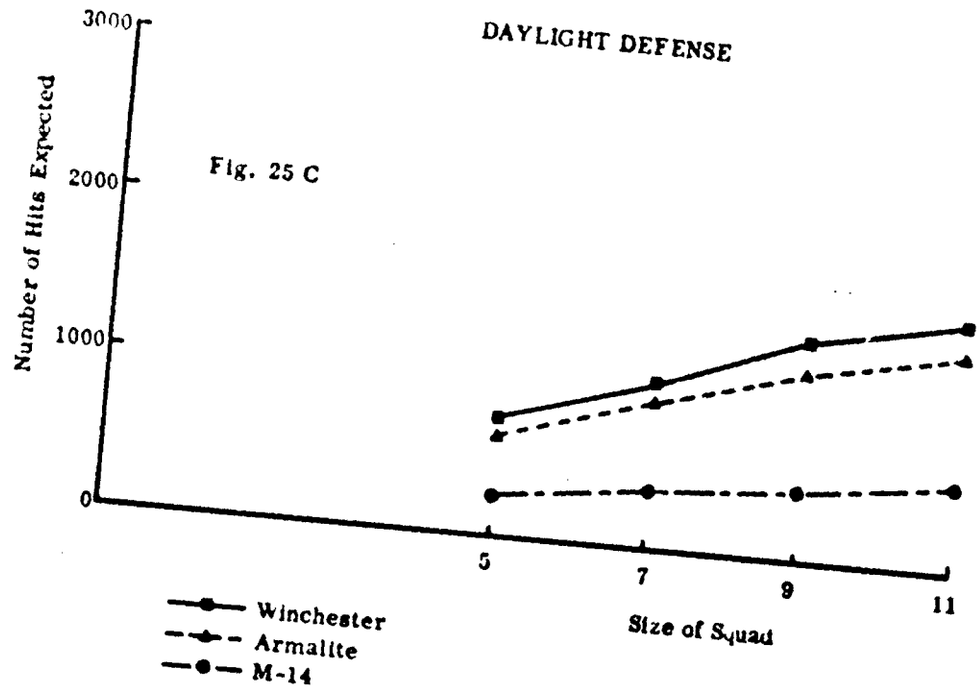


Fig. 25 C

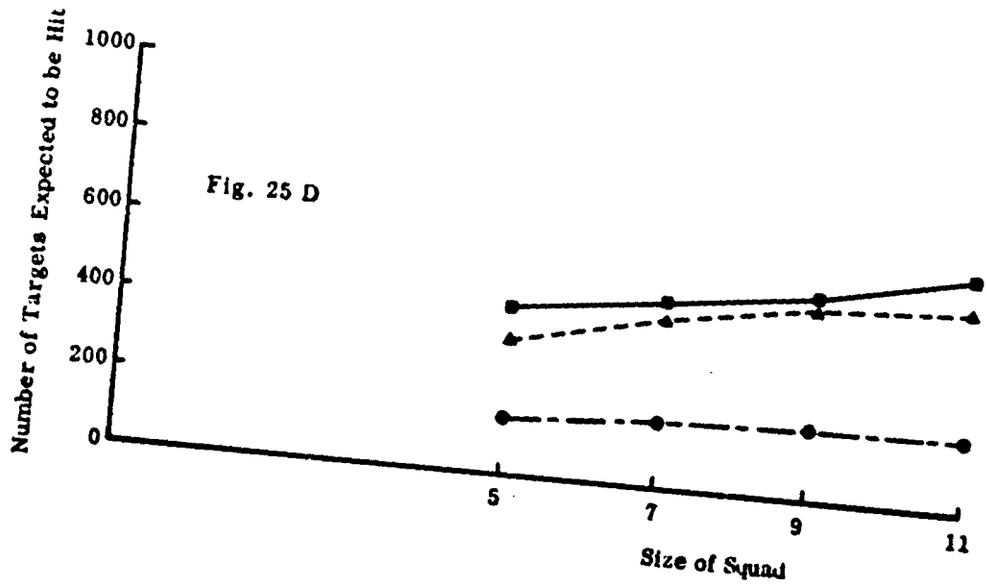


Fig. 25 D

TABLE 1

SQUAD PERFORMANCE AS A FUNCTION OF SQUAD SIZE

Column No.:	1 Squad Size	2 No. of Targets Hit	3 No. of Hits	4 No. of Rounds Expended	5 Hit Probability (Col 3/Col 4)	6 Hit Distribution (Col 2/Col 3)
Daylight Attack -	5	1080	2013	4555	0.443	0.535
	7	1219	2548	6261	0.407	0.478
	9	1425	3363	8216	0.409	0.424
	11	1500	4064	10218	0.398	0.369
Daylight Defense -	5	829	1516	5475	0.2768	0.5468
	7	968	2115	8143	0.2597	0.4577
	9	1058	2666	10922	0.2441	0.3968
	11	1129	3101	13510	0.2295	0.3641

TABLE 2

SQUAD PERFORMANCE AS A FUNCTION OF RIFLE TYPE

Column No:	1 Rifle Type	2 No. of Targets Hit	3 No. of Hits	4 No. of Rounds Expended	5 Hit Probability (Col 3/Col 4)	6 Hit Distribution (Col 2/Col 3)
Daylight Attack -	Winchester	1763	4141	9638	0.429	0.426
	Armalite	1621	3594	10075	0.357	0.451
	M-14	1840	4258	9537	0.447	0.432
Daylight Defense -	Winchester	1392	3263	12601	0.2589	0.4266
	Armalite	1221	2826	12671	0.2239	0.4321
	M-14	1371	3309	12778	0.2590	0.4143

TABLE 3

SQUAD PERFORMANCE AS A FUNCTION OF FIRER PROFICIENCY

Column No:		1	2	3	4	5	6
		Platoon Proficiency Rank	No. of Targets Hit	No. of Hits	No. of Rounds Expended	Hit Probability (Col 3/Col 4)	Hit Distribution (Col 2/Col 3)
Daylight Attack: -		1	1807	4102	9364	0.438	0.440
		2	1671	3552	9387	0.378	0.470
		3	1746	4339	19499	0.413	0.402
Daylight Defense -		1	2043	4940	18957	0.2[illegible]6	0.4136
		2	1941	4458	19093	0.2335	0.4354

TABLE 4

SQUAD PERFORMANCE AS A FUNCTION OF SQUAD SIZE – RIFLE TYPE

	Column No:	1	2	3	4	5	6
	Squad Size	Rifle Type	No. of Targets Hit	No. of Hits	No. of Rounds Expended	Hit Probability (Col 3/Col 4)	Hit Distribution (Col 2/Col 3)
Daylight Attack	5	Winchester	376	713	1513	0.471	0.528
		Armalite	331	606	1596	0.380	0.546
		M-14	373	699	1446	0.484	0.534
	7	Winchester	402	860	2058	0.419	0.467
		Armalite	388	792	2123	0.373	0.490
		M-14	429	896	2083	0.403	0.479
	9	Winchester	492	1179	2716	0.434	0.417
		Armalite	442	1037	2879	0.360	0.427
		M-14	491	1147	2621	0.437	0.428
	11	Winchester	493	1389	3354	0.414	0.355
		Armalite	460	1159	3477	0.334	0.398
		M-14	547	1516	3367	0.447	0.361
Daylight Defense	5	Winchester	294	519	1808	0.287	0.566
		Armalite	244	446	1850	0.241	0.547
		M-14	291	551	1817	0.303	0.528
	7	Winchester	334	721	2750	0.262	0.463
		Armalite	287	617	2645	0.233	0.465
		M-14	347	777	2748	0.283	0.447
	9	Winchester	357	953	3615	0.264	0.375
		Armalite	342	824	3653	0.226	0.415
		M-14	359	889	3654	0.243	0.404
	11	Winchester	407	1069	4428	0.241	0.381
		Armalite	348	939	4523	0.208	0.371
		M-14	374	1092	4559	0.240	0.342

TABLE 4A

HIT EXPECTANCY AND TARGET EXPECTANCY
AS FUNCTIONS OF SQUAD SIZE - RIFLE TYPE

	Column No:	1 Squad Size	2 Rifle Type	3 No. of Hits Expected	4 No. of Targets Expected to be Hit
Daylight Attack		5	Winchester	1,225	647
			Armalite	988	538
			M-14	425	227
		7	Winchester	1,630	764
			Armalite	1,455	714
			M-14	568	272
		9	Winchester	2,257	941
			Armalite	1,872	801
			M-14	771	329
		11	Winchester	2,691	956
			Armalite	2,165	858
			M-14	986	354
Daylight Defense		5	Winchester	746	424
			Armalite	627	343
			M-14	267	141
		7	Winchester	1,022	472
			Armalite	909	425
			M-14	374	166
		9	Winchester	1,373	515
			Armalite	1,175	489
			M-14	428	172
		11	Winchester	1,566	598
			Armalite	1,352	500
			M-14	528	180

TABLE 5

SQUAD PERFORMANCE AS A FUNCTION OF SQUAD SIZE – PROFICIENCY

	Column No:	1	2	3	4	5	6
	Squad Size	Proficiency Rank	No. of Targets Hit	No. of Hits	No. of Rounds Expended	Hit Probability (Col 3/Col 4)	Hit Distribution (Col 2/Col 3)
Daylight Attack	5	1	350	637	1484	0.429	0.549
		2	323	555	1464	0.379	0.582
		3	407	826	1607	0.514	0.493
	7	1	425	846	2023	0.418	0.503
		2	382	776	1992	0.390	0.492
		3	412	926	2246	0.412	0.445
	9	1	503	1207	2663	0.453	0.417
		2	478	997	2622	0.380	0.479
		3	444	1159	2931	0.396	0.383
	11	1	529	1412	3194	0.442	0.375
		2	488	1224	3309	0.370	0.399
		3	483	1428	3715	0.384	0.338
Daylight Defense	5	1	414	747	2712	0.275	0.554
		2	415	759	2763	0.278	0.540
	7	1	502	1120	4111	0.272	0.448
		2	466	995	4032	0.247	0.468
	9	1	528	1337	5409	0.247	0.395
		2	530	1329	5513	0.241	0.399
	11	1	599	1736	6725	0.258	0.345
		2	530	1364	6785	0.201	0.389

TABLE 6

SQUAD PERFORMANCE AS A FUNCTION OF PROFICIENCY – RIFLE TYPE

	Column No:	1	2	3	4	5	6
	Proficiency Rank	Rifle Type	No. of Targets Hit	No. of Hits	No. of Rounds Expended	Hit Probability (Col 3/Col 4)	Hit Distribution (Col 2/Col 3)
Daylight Attack	1	Winchester	556	1280	3028	0.423	0.434
		Armalite	584	1293	3184	0.406	0.452
		M-14	667	1529	3152	0.485	0.436
	2	Winchester	623	1314	3184	0.413	0.474
		Armalite	529	1126	3366	0.334	0.470
		M-14	519	1112	2837	0.392	0.467
	3	Winchester	584	1547	3426	0.452	0.378
		Armalite	508	1175	3525	0.333	0.432
		M-14	654	1617	3548	0.456	0.404
Daylight Defense	1	Winchester	724	1786	6295	0.284	0.405
		Armalite	610	1460	6415	0.228	0.418
		M-14	709	1694	6247	0.271	0.419
	2	Winchester	668	1476	6306	0.234	0.453
		Armalite	611	1366	6256	0.218	0.447
		M-14	662	1615	6531	0.247	0.410

TABLE 7

SQUAD PERFORMANCE – NIGHT DEFENSE SITUATION

Rifle Type	No Illumination		Flares	
	No. of Rounds Fired	No. of Hits	No. of Rounds Fired	No. of Hits
Winchester	4194	16	4127	315
Armalite	4406	28	4259	249
M-14	4316	29	4359	258

TABLE 8

SQUAD PERFORMANCE AS A FUNCTION OF FULLY AUTOMATIC FIRE - SEMI-AUTOMATIC FIRE DEFENSE AT 100 YARDS.

Column No. :		2	3	4	5	6
Weapon Type	Fire Technique	No. of Targets Hit	No. of Hits	No. of Rounds Expended	Hit Probability (Col 3/Col 4)	Hit Distribution (Col 2/Col 3)
M-14	Semi-Automatic	31	127	335	0.379	0.244
Armalite	Fully Automatic	27	71	819	0.087	0.380

TABLE 9 A

RIFLE STOPPAGES DURING DAYLIGHT ATTACK

(LISTED BY CAUSES)

	Winchester	Armalite	M-14
Total number of weapon runs —	374	384	384
Number of runs with one or more stoppages —	71	35	42
Causes of stoppages:-			
A. Weapon failure --	70	18	23
1. Round did not fire (broke firing pin) --	13		3
2. Failed to eject --	30	9	11
3. Shell would not chamber --	3	3	5
4. Bolt not closed --	1		
5. Failed to feed --	13	5	4
6. Broken parts --	4		
7. No reason given (bolt fell apart, extractor pin came out, broken hand guard) --	7		
8. Bolt stuck closed —		1	
B. Personnel failure --	3	17	21
1. Safety on --		3	3
2. No round in chamber (after changing magazines, round was not chambered) --		2	2
3. Run out of ammunition —		1	2
4. Failed to fire (bolt not closed) --		9	3
5. Weapon not assembled correctly --			1
6. Magazine not seated —	3	2	10
C. Bad ammunition --	0	3	2
D. Unknown --	3	5	4
Total Runs with Stoppages —	76*	43*	50*

* Breakdown does not add up to total because some runs had two or more different types of stoppages.

TABLE 9 B

RIFLE STOPPAGES DURING DAYLIGHT DEFENSE

(LISTED BY CAUSES)

	Winchester	Armalite	M-14
Total number of weapon runs —	327	337	337
Number runs with 1 or more stoppages —	64*	34*	8
Causes of stoppages:-			
A. Weapon failure —	71	33	6
1. Failure to eject —	45	12	1
2. Broken parts in bolt —	12		
3. Failure to feed —	9	7	2
4. Trigger stuck —	2	2	
5. Sights loose —	1		
6. Bolt failed to close —	1	4	3
7. Round jammed in chamber —	1	4	
8. Firing pin not striking ammunition —		3	
9. Double feed —		1	
B. Bad Ammunition —	3		1
C. Personnel failure —	1		1
1. Magazine not seated —	1		1
D. Unknown —		2	
Total Runs with Stoppages —	75*	35*	8

* Breakdown does not add up to total because some runs had two or more different types of stoppages.

2. LOGISTICAL IMPACT

a. Introduction

The anticipated battle load in ammunition, for a soldier armed with the M-14 rifle, consists of 100 rounds of ammunition in five 20-round magazines plus 120 rounds in two bandoleers, for a total of 220 rounds*. The weight of this weapon-ammunition combination is 22.39 pounds. An examination of the lightweight high-velocity rifle-ammunition combinations reveals the following:

(1) With a combat load weight limit of 22.39 pounds, a soldier armed with the Armalite can carry 125 rounds of ammunition in five 25-round magazines plus 524 rounds in bandoleers (total: 649 rounds).

(2) With a combat load weight limit of 22.39 pounds, a soldier armed with the Winchester can carry 100 rounds in five 20-round clips plus 552 rounds in bandoleers (total: 654 rounds).

(3) Matching, on a round-for-round basis, the currently envisioned M-14 weapon-ammunition load for the individual soldier (rifle plus 220 rounds), the soldier armed with the Armalite and 220 rounds would carry a battle load of 12.20 pounds. This represents a weight decrease of 10 pounds in the rifleman's overall combat load.

b. Discussion

(1) The key factor in comparison of the Lightweight High-Velocity Systems is the ammunition-carrying capability of the combat soldier armed with a weapon from either system. Without adding any weight to his combat load, the rifleman armed with a lightweight rifle can carry almost three times as much ammunition as the rifleman armed with the M-14 (approximately 650 rounds versus 220 rounds).

(2) The effect of logistics on squad size indicates, as pointed out in the foregoing analysis, that squads armed with either of the lightweight rifle systems are more effective than squads of even much larger size armed with the M-14 rifle, when the criterion of effectiveness is the number of hits expected or

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* Report on Project No. 2787, US Army Infantry Board, 27 May 58, Evaluation of Small Caliber High-Velocity Rifles - Armalite (AR-15).

the number of targets expected to be hit. It has already been stated that the five-man squad with the Winchester will be superior to the eleven-man squad with the M-14. This fact does not of itself determine an optimum squad size in that an eleven-man squad armed with the Winchester rifle will be superior to the five-man squad armed with the same rifle. Consequently, a decision as to squad size must be based on other considerations, e.g., span of control.

(3) It should be pointed out that the foregoing statements concerning squad effectiveness dealt only with the number of hits expected or the number of targets expected and were not based on the comparative lethalities of the two weapons.

3. OPINION POLL

a. Introduction

Two different but complementary types of information were obtained from the Lightweight High-Velocity Rifle experiment: Objective data in the form of measured or counted quantities, and subjective data derived from an opinion survey of the troops engaged in firing. The analysis contained in this section pertains to information of the latter category. An objective treatment of the subjective data has been obtained through mathematical analysis of responses to written questionnaires.

A copy of the questionnaire used is contained in Annex C.

b. Results of Military Questionnaire Analysis

In collecting information through the military information questionnaire, the following procedure was used: First, responses were obtained from all men taking part in the experiment as firers during the period 15 August - 19 December 1958. The responses made to the questions at the termination of this period (when the firers had completed the attack phase, but had not yet started the defensive phases) are called "initial" measurements. They are the opinions obtained from the men before they had fired the full course of the experiment. Opinions were again sampled following the period 23 January - 22 March 1959 (when firers had completed the full course of the experiment). These are called "final" measurements. Opinions of the men after having fired the full course of the experiment are compared with the earlier opinions in order to indicate trends which developed with increased and more varied

experience.

Initial measurements were made on a total of 16 questions (Questions 1 - 16 of the questionnaire included in Annex C). Final measurements were made on the same 16 questions and on 12 additional questions (Questions 17 - 28 of the questionnaire). In the final measurements responses were obtained from 22 of the 43 men who had previously responded during the initial measurements. In addition, 10 men who participated during most of the experiment were sampled. The responses of all firers were tabulated, and tests of the statistical significances of differences were conducted. The results, as presented in Table 10, are shown as percentages of responses to the various categories of answers possible for each question. In addition to the first 28 questions (which were based on weapons preference), 6 open-end questions were asked for the purpose of investigating opinions on advantages and disadvantages of the weapons. These will be analyzed in paragraph (9) below.

In comparing changes in preferences between the initial and the final measurements, the statistical significance of differences in the indicated preferences for rifles was tested. This comparison was possible on the first 15 questions common to both sets; the questions are divided by this test into two groups, those in which preferences among rifles changed significantly (Category 2 - 8 questions). The sixteenth question (Q. 16) was not related to weapons, as such, but to caliber of weapon used. This is discussed in paragraph (3) below.

(1) Category 1 - Initial and final measures of rifle preferences differing significantly.

In all cases where opinions changed significantly between the initial and the final measurements (Questions 1, 2, 6, 7, 11, 12 and 15), the changes were consistent in indicating an increased preference for the Armalite rifle and decreased preference for both the M-14 and the Winchester rifles. This is shown in Table 10, where the data, in the form of percentages, are reported along with the levels of significance associated with the differences between initial and final responses within each particular survey. It is of interest to note that one-half or more of the riflemen rated the Armalite best (the most preferred) in each of these seven questions on the final rating (given after the experiment).

(2) Category 2 - Initial and final rifle preferences not differing significantly.

Where opinions did not change significantly

between initial and final measurements, three patterns of preferences may be observed: a. A consistent and overwhelming preference for one of the weapons; b. An equally consistent and overwhelming rejection of one of the weapons; and, c. The mixed case in which there is both a preference for one weapon and a rejection of another, but neither is "overwhelming". The data are presented in the three sections of Table 11.

(a) Strong preference for one weapon.

In the uppermost section of Table 11, it may be seen that there was evidently a strong and persistent preference for the M-14 over both other rifles on the items covered in Questions 3 and 13 — items relating to "sights" and to "accuracy".

(b) Low preference for (rejection of) one weapon.

In the center section of Table 11 it may be seen that there was evidently a consistent rejection of the Winchester rifle and relatively equal preferences for the other two rifles with respect to Questions 4, 8, 9 and 14.

(c) Mixed preferences.

The responses to the remaining two items, Questions 5 and 10, indicate consistent rejection of the Winchester (but not as strong a rejection as in (b) above, and a mixed preference (for the Armalite regarding "grip", and the M-14 with respect to the "ease of cleaning in the field").

(3) Larger versus small caliber (Q. 16).

Initially, there were no significant difference in preferences for the larger or small caliber ammunition ($p > .80$). In the final analysis, there was a statistically significant preference for the small caliber ($p < .01$). That is consistent with the general preference for the Armalite rifle that apparently developed during the course of experimentation. (See Table 12.)

(4) Weapons preference after experimentation.

In Table 13, a summary is presented of the data obtained by administration of the preference questionnaire during the period following the completion of field experimentation in March 1959. Statistically significant differences in

preferences were found to exist for all 27 items. Inspection of the "preferred preference" column of Table 12 readily leads to a short summary of the findings: In general, the firers after having completed the experiment preferred the Armalite rifle and rejected (had lowest preferences for) the Winchester rifle. That is to say, in only three cases (Questions 3, 13, and 26) did the firers clearly prefer the M-14 rifle over the Armalite*; in all other cases they preferred either the Armalite over both the M-14 and the Winchester, or they preferred the Armalite and/or the M-14 over the Winchester. These preferences are discussed in order, following Table 13.

(5) Armalite clearly preferred over other two.

Q. No.	Subject
2	Weight
5	Grip
6	Ease of loading
7	Speed of loading
9	Ease of disassembly
11	Recoil
12	Quick return
17	Least climb
20	Accuracy in full automatic
23	Liked best by experimenters
24d	Rather use in night combat w/o flares
25d	Most deadly at 100 yards

These may be interpreted to indicate a general preference for the Armalite (Questions 2, 5, 6, 7, 9, 23) and a specific preference for this rifle used on full automatic fire (Questions 11, 12, 17, 24d) or at short distances (Question 25d) where accuracy may be less important than speed of fire.

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* See paragraph (6) below.

(6) M-14 clearly preferred over other two.

Q. No.	Subject
3	Sights
13	Accuracy
26	Most deadly at 300 yards

In general, it appears from the firers' preference that they believed the M-14 to be the most accurate rifle (Q. 13). Their interpretation of "accuracy" here was evidently heavily weighted by their opinion of the relative quality, from the firer's viewpoint, of this rifle's sights (Q. 3), and probably was not interpreted to mean bench accuracy. They also indicated (Q. 26) a preference for the M-14 rifle as being the "most deadly at 300 yards" — a distance at which firing accuracy and sights may be considered quite important elements of deadliness".

(7) Armalite and M-14 preferred over Winchester.

Q. No.	Subject
1	Feel
4	Durability
8	Ease of getting ready to fire
14	Dependability
15	Overall infantry use
18	Least trigger backlash
19	Worked best in rain
20	Most malfunctions on full automatic
22	Most other firers would want for combat
25d	Rather use in night combat without flares
27	Most deadly at 200 yards

These may be interpreted as a general rejection

of the Winchester rifle relative to the other two weapons (Q. 1, 8, 15, 18, 22, 25d, 27), and a specific rejection of the Winchester on all items dealing with durability and dependability (Q. 4, 14, 19, 20). The rejection of the Winchester is further illustrated in the responses to several other questions where the Armalite was clearly preferred over the M-14 which in turn was clearly preferred over the Winchester (Q. 9, 23, 24d, 28).

(8) Questions relating to night combat (Q. 24 and 25).

Summarized: If flares are being used, firers prefer not to use tracer ammunition. If flares are not being used, firers definitely prefer to fire automatic. In both cases, preferences are for Armalite over M-14, and both over the Winchester.

(a) Night combat with flares being used (Q. 24).

1. No statistical significance ($p > .20$) in preferences for automatic (60 percent) versus semi-automatic fire (40 percent).

2. Prefer ($p < .01$) not to fire tracer ammunition (85 percent).

3. No difference ($p > .10$) in preferences for bipod (17 percent), sandbag (38 percent), or neither (45 percent).

4. As previously stated, a definite preference ($p < .01$) for using Armalite (70 percent) over the M-14 (30 percent), and either of these over the Winchester (0 percent).

(b) Night combat without flares (Q. 25).

1. Preference ($p < .01$) for automatic (76 percent) versus semi-automatic fire (24 percent).

2. No statistically significant difference ($p > .30$) in preferences for tracer (59 percent) or non-tracer ammunition (41 percent).

3. Slight preference ($p < .05$) for use of neither bipod nor sandbag (52 percent) over either sandbag along (34 percent) or bipod alone (14 percent).

4. Definite preference ($p < .01$) for

Armalite (62 percent) over M-14 (35 percent) and both of these over the Winchester (3 percent).

(9) Opinions concerning major advantages and disadvantages of the rifles.

At the time of initial measurements of preferences, all firers were asked to list what they thought were the major advantages and the major disadvantages of each of the three rifles. Again, at the time of the final measurements of preferences, each firer responding to the "Military Information Questionnaire" was asked to list what he thought was the one most important advantage of each of the three rifles and the one most important disadvantage of each.

The first advantage (or disadvantage) listed for each rifle by each man was recorded, and the tabulation of the things listed during the initial measurements was compared with those listed during the final measurements. In making this comparison, the responses were grouped into four major categories:

1. Items relating to sights, range, or accuracy.

2. Items relating to weight, balance, feel or grip.

3. Items relating to malfunctions, safety, or dependability; and

4. A miscellaneous grouping of items such as caliber, weight of ammunition, ease of cleaning and disassembly, automatic fire, none, etc. The groups were devised principally on the basis of the results obtained with the questionnaire proper; i.e., with the results presented above in paragraphs (1) through (8).

In no case did the opinions (advantages or disadvantages) change between initial and final measurements. That is to say, essentially identical advantages (and disadvantages) were listed for the three rifles with the same frequencies during both the initial and the final measurements. Because of this finding, and for simplicity of presentation, only the results of the final measurements are presented below in Table 14, (Advantages) and Table 15, (Disadvantages).

(a) Major advantages of the LWEV weapons.

The data presented in Table 14 indicate

that the major advantage of both the Armalite and the Winchester had to do with the lightweight characteristics of these two weapons. Typical of the comments made, and of the items included within the category, "Weight", were the words: "weight", "balance", "feel", "grip", "easy to fire", easy to load", etc. The major advantage credited to the M-14 had to do principally with the preferred sights on that rifle; typical comments included reference to "sights", "accuracy", "long range", etc.

(b) Major disadvantages of the LWHV weapons.

In Table 15, the items listed by the firers as major disadvantages of each of the three rifles are summaried in terms of the same four general categories used above. The men apparently thought the major disadvantages of the Armalite rifle were related to the sights and the range of the weapon, and to its accuracy insofar as accuracy is affected by sights and range. The major disadvantage of the M-14 was listed as its weight and its handling characteristics (including items such as the slowness in loading, awkwardness of magazine, etc.). The Winchester rifle's major disadvantage was nearly universally listed as related to its dependability (or, rather, its lack of dependability); typical of the comments made were words such as "fragile", "malfunctions", "undependable", "not safe", "weak bolt", etc.

(c) Summary of opinions concerning advantages and disadvantages.

Perhaps the most remarkable thing about the data presented in this section is the consistency with which they agree with the findings reported in the preceding three subsections. It is apparent that these men who had the experience of handling and firing all three weapons show a preference for the lighter-weight of the LWHV rifles -- they indicate this both in naming "weight", etc., as the major advantage of the Armalite and the Winchester rifles, and in naming it as the major disadvantage of the M-14 rifle. It is also apparent that these men prefer the type of sights found on the M-14 rifle to those found on the other weapons, and it was the sights of the Armalite that was given as the major disadvantage of that weapon. Finally, these men apparently rate "dependability" highly, when judging weapons of the types used in this study, and their rejection of the Winchester (cf. sub-section 2, above) is certainly based upon their belief that the weapon was not dependable as indicated by their listing this as the major disadvantage of that rifle.

Table 10

PERCENTAGE OF "BEST" RATINGS GIVEN EACH OF THE CANDIDATE WEAPONS, WHERE INITIAL AND FINAL RATINGS DIFFERED SIGNIFICANTLY BY STATISTICAL TEST.

Question		Time of Rating	Number of Raters	Weapon			Level of Significance of Differences	
Number	Subject			Armalite	M-14	Winchester	Within each Survey	Between Surveys
1	Feel	Initial Final	43 32	7% 50%	54% 41%	40% 9%	$p < .01$ $p < .02$	$p < .01$
2	Weight	Initial Final	43 32	30 81	23 3	47 16	$> .10$ $< .01$	$< .01$
6	Ease of Loading	Initial Final	42 32	57 88	19 9	24 3	$< .01$ $< .01$	$< .02$
7	Speed of Loading	Initial Final	43 32	53 91	23 6	23 3	$< .02$ $< .01$	$< .01$
11	Recoil	Initial Final	43 32	49 88	21 3	30 9	$> .05$ $< .01$	$< .01$
12	Quick Return	Initial Final	43 32	14 56	53 25	33 19	$< .01$ $> .05$	$< .01$
15	All Around Inf.Use	Initial Final	43 32	12 56	70 44	19 0	$< .01$ $< .01$	$< .01$

*Chi-Square distribution used.

Table 11

PERCENTAGE OF "BEST" RATINGS GIVEN EACH OF THE CANDIDATE WEAPONS, WHERE INITIAL AND FINAL RATINGS DID NOT DIFFER SIGNIFICANTLY BY STATISTICAL TEST.

Question		Time of Rating	Number of Raters	Weapon						Level of Significance of Differences	
Number	Subject			Armalite		M-14		Winchester		Within	Between
3	Sights	Initial	43	0%		95%		5%		< .01	>.30
		Final	32		3%		91%		6%	< .01	
13	Accuracy	Initial	43	0		81		19		< .01	>.05
		Final	32		6		91		3	< .01	
4	Durability	Initial	42	31		67		2		< .01	>.20
		Final	32		47		53		0	< .01	
8	Ease of getting ready	Initial	43	35		53		12		< .01	>.30
		Final	32		47		50		3	< .01	
9	Ease of Disassembly	Initial	43	77		19		5		< .01	>.50
		Final	32		69		28		3	< .01	
14	Dependability	Initial	42	31		69		0		< .01	>.70
		Final	32		34		66		0	< .01	
5	Grip	Initial	41	51		39		10		< .01	>.10
		Final	32		69		19		12	< .01	
10	Ease of Field Cleaning	Initial	43	37		44		19		>.10	>.50
		Final	31		29		55		16	<.05	

TABLE 12

LARGER VERSUS SMALLER CALIBER (Q. 16)

Time of Rating	Number of Raters	Percentage Preferring		Percentage Indicating No Preference
		Larger Caliber	Smaller Caliber	
Initial	43	42	44	14
Final	32	22	66	12

Table 13

PERCENTAGE OF "BEST" RATINGS GIVEN EACH OF THE CANDIDATE WEAPONS AFTER EXPERIMENTATION.

Question Number	Subject	Weapon: Armalite	Weapon: M-14	Weapon: Winchester	Level of Significance	Predominant Preference ** For	Predominant Preference ** Against
1	Feel	50%	41%	9%	< .02	--	--
2	Weight	81%	3	16	< .01	A	--
3	Sights	3	91	6	< .01	M	--
4	Durability	47	53	0	< .01	--	--
5	Grip	69	19	12	< .01	A	--
6	Ease of Loading	88	9	3	< .01	A	--
7	Speed of Loading	91	6	3	< .01	A	--
8	Ease of Getting Ready	47	50	3	< .01	A	--
9	Ease of Disassembly	69	28	3	< .01	A	--
10	Ease of Field Cleaning	29	55	16	< .05	--	--
11	Recoil	88	3	9	< .01	A	--
12	Quick Return	56	25	19	< .05	A	--
13	Accuracy	6	91	3	< .01	M	--
14	Dependability	34	66	0	< .01	--	--
15	Over-all Inf. Use	56	44	0	< .01	--	--
17	Least Climb	65	13	23	< .01	A	--
18	Least Trigger Backlash	53	39	9	< .01	--	--
19	Worked Best in Rain	67	33	0	< .01	--	--
20	Accuracy on Full Auto	68	25	7	< .01	A	--
21	Most Malf. on Full Auto	11	14	75	< .01	--	--
22	Wpn most men would want for combat	63	37	0	< .01	--	--
23	Wpn liked best by Experimenter	79	21	0	< .01	A	--
24d	Rather use in Night Combat with Flares	70	30	0	< .01	A	--
25d	Rather use in Night Combat w/o Flares	62	35	3	< .01	--	--
26	Most deadly at 300 yd	12	88	0	< .01	M	--
27	Most deadly at 200 yd	53	44	3	< .01	--	--
28	Most deadly at 100 yd	72	25	3	< .01	A	--

*There were 32 respondents to the questionnaire in all. All had previously responded during the Initial measurements. There were omissions that reduced the total number of respondents for certain questions: Questions 10 and 17 are based on 31 answer sheets, Questions 19 and 22 on 30, Question 23 on 29 responses, Questions 20 and 21 on 28 responses.

** A predominant preference was defined as a preference so strong that there was a statistically significant difference (at the .05 level or better) between the weapon for (or against) which the preference existed and each of the other two rifles.

Table 14

PERCENTAGE DISTRIBUTION OF ITEMS GIVEN AS THE "ONE MOST IMPORTANT ADVANTAGE" OF EACH OF THE CANDIDATE WEAPONS BY 32 FIRERS QUESTIONED AFTER EXPERIMENTATION.

	Weapon		
	Armalite	M-14	Winchester
Sights (incl. Accuracy and Range)	3	88*	9
Weight (incl. Balance, Feel and Grip)	59*	6	53*
Dependability	16	6	0
Miscellaneous	22	0	38
Sum of Percentages	100	100	100
Number of Items	32	32	32

* - maximum values

Table 15

PERCENTAGE DISTRIBUTION OF ITEMS GIVEN AS THE "ONE MOST IMPORTANT DISADVANTAGE" OF EACH OF THE CANDIDATE RIFLES BY 32 FIRERS QUESTIONED AFTER EXPERIMENTATION.

	Weapon		
	Armalite	M-14	Winchester
Sights (incl. Accuracy and Range)	75*	0	0
Weight (incl. Balance, Feel and Grip	3	66*	0
Dependability	9	3	91*
Miscellaneous	12	31	9
Sum of Percentages	99	100	100
Number of Items	32	32	32

* - maximum values

4. MILITARY EVALUATION

a. Introduction

This military evaluation of the results of the LWHVR Experiment consists of a discussion of observed factors of military significance in light of the foregoing scientific and military analyses.

b. Objective 1: Impact of the LWHVR system on squad size.

Primarily, adoption of the lightweight high-velocity rifle system would permit a smaller size squad to have greater hit capability than the present-day eleven-man squad (TO&E 7-17C), armed with the M-14. In particular, a five-man squad armed with the Winchester lightweight rifle, carrying 22-1/2 pounds in arms and ammunition per man could expect to score up to 40 percent more hits and achieve approximately 2-1/2 times greater hit distribution than the current eleven-man squad armed with the M-14, also carrying 22-1/2 pounds in arms and ammunition. The advantages of a smaller-sized squad are obvious — easier to control and more mobile, easier to transport and easier to supply. The greatest advantage lies in the economy of manpower that can be realized through reduction in squad size. And all this can be achieved while at the same time increasing the squad hit potential. Squad strengths of five, six or seven men are suggested as candidate sizes to consider in conjunction with the Lightweight, High-Velocity Rifle system. In substituting a five-man squad for an eleven-man squad on a given frontage the question may arise: "Why not double the frontage and still retain the eleven-man squad size?" The answer concerns span of control. This experiment was conducted on three ranges varying from 90 to 110 yards in width. Through constant observation, it became apparent the average leader had reached his limit in trying to tactically control a squad spread across this frontage. Another question may be raised: "Why not saturate a 100 yard frontage with an eleven-man squad?" The obvious answer is that such a deployment would increase vulnerability through over-concentration and would not be economical of manpower. This last point seems critical when considering the US Army vis à vis the potential enemy. Admittedly, many other factors must be considered in making the final determination of squad size including expected attrition rate, other armament requirements, logistical support requirements, tactical flexibility and envisioned squad missions. Military evaluation of this experiment indicates a smaller sized squad would appear adequate to do the job when armed with the LWHVR system.

c. Objective 2: To compare the effectiveness of squads armed with weapons of the LWHVR system with squads armed with the M-14 rifle.

(1) Hit Probability

As judged by percentage of hits per round fired, the number of hits scored by the LWHVR system was comparable to that scored by the M-14. As a result of military observations and opinion poll of the using troops (See Section III, Part 3), certain opinions may be ventured to explain this.

(a) Throughout the experiment, certain weaknesses were noted in the candidate rifles of the LWHVR system. The Winchester which was comparable to the M-14 in hit capability had an extreme breakdown rate, particularly when fired on full automatic. In fact during the experiment all the Winchester spare parts were consumed, and of the twelve Winchester rifles originally available only three were operational at the termination of the experiment. This deleted the Winchester from the last few days of automatic fire runs. As a result, the troops lost confidence in this rifle and rejected it completely as a rifle to carry in combat (See Section III, Part 3). However, the Winchester rifle has many desirable qualities. First, the Winchester is as accurate as the M-14 and is the outstanding member of the LWHVR system in this respect. The Winchester has no noticeable recoil when fired on full automatic, and is a fraction of a pound lighter than the Armalite. The sights appear to be a particularly worthwhile feature of the weapon.

(b) The other candiate weapon representing the lightweight high-velocity rifle system was the Armalite AR-15, caliber .222. The Armalite, while significantly below the other two rifles in hit capability, was comparable to the M-14 in durability, freedom from malfunction, and freedom from parts breakage. It handled well. It did not overheat or smoke, as did the M-14, when fired on full automatic. The Armalite became the favorite weapon of the using troops, who appreciated most of all its reliability, its light weight, and its comfortable handling under all circumstances including full automatic fire. It is suspected that the serious deficiency of the Armalite rifle with regard to accuracy may be attributed primarily to its sights. The Armalite sights were the feature most criticised by the experimentation firers. A possibility of improving the sights would be to lengthen the distance between the front and rear sight (sight radius) from the present 18.25 inches to 25 inches, thereby increasing the Armalite sight radius by 1/3 and making it approximately the same as that of the other two rifles. Another possibility would

be to redesign the sight so that the amount of area visible around the target when the sights are in alignment is increased. It is also considered that the windage and elevation adjustments on the Armalite sights are too complex and could be modified to approach the simplicity of the Winchester sights.

(c) In summary, a reliable hit capability equal to that of the M-14 can be achieved from the Lightweight High-Velocity system through combining the demonstrated virtues of the two LWHV Rifles used in this experiment.

(2) Hit distribution

Another result presented through scientific analysis of the experiment was "that the hit distribution of the lightweight high-velocity rifles was better than that of the M-14". Hit distribution refers to the total number of targets hit divided by the total number of hits.

(a) A possible explanation for the superior hit distribution capability of the LWHVR system is that the lighter weapons could be shifted far more easily and rapidly from target to target and could be aligned more quickly than the M-14. This explanation is sustained by the troop opinion poll wherein the firers indicated a preference for the Armalite rifle and commented favorably on its weight, good grip, low recoil, lack of climb, and quick return to alignment. In fact, lack of climb and quick return may be the factors which allowed the Armalite in one special situation -- wherein the Armalite, fired on full automatic (in short bursts), was compared to the M-14, also fired on full automatic (in short bursts), at a range of 100 yards -- to achieve both more hits and a greater hit distribution than the M-14 (See Table 16). It appeared that the extreme cumulative recoil and rapid overheating of the M-14 seriously degraded performance when fired on full automatic.

(b) From constant observations on the line during the experiment, it became evident that even with the LWHVR system weapons with their negligible recoil and low rate of climb, long bursts of automatic fire (more than 7 rounds per burst) were ineffective at ranges of 100 yards and beyond. On the other hand, short-burst automatic fire (3 to 6 rounds) using the LWHVR system weapons appeared to be effective, particularly at a range of 100 yards. Another factor which was noted through observation on the line was the automatic fire technique which the competing squads were employing with the LWHV rifles during automatic-fire runs. They deliberately aimed the first shot of each burst so that it would strike in front of the target, and by firing a burst of 3

to 6 rounds they "walked the bullets" through the target as the muzzle climbed. When the target appeared suddenly for a few seconds there was little time for slow, careful aiming. It is possible that massed troop assault would be particularly vulnerable to this type of automatic fire. All this would seem to reinforce the premise that every man armed with an LWHV rifle must have a rifle capable of being set on a cyclic rate of full automatic at the discretion of the individual rifleman. This is required in order to exploit the special characteristics of the LWHVR system.

(c) In summary, the advantages in hit distribution displayed by the LWHVR system appear to result from these characteristics: light weight, a better grip, and on automatic fire, low recoil, low rate of climb and a quick return, all of which resulted in a more easily handled, more controllable rifle. Further, the most potentially deadly fire technique with the LWHVR system appears to involve short-burst, full automatic fire.

(3) Night firing capabilities

(a) The representative rifle of the LWHVR system that was generally the same as the M-14 in hit capability was the Winchester, caliber .224. When fired in a series of runs at night under conditions of flare illumination, the total hits achieved by the Winchester exceeded those of the M-14 by 29 percent. It is believed, however, that under these particular circumstances this superiority is attributable largely to the Winchester rifle sight itself rather than to some inherent lightweight high-velocity rifle characteristic. The Winchester sight appeared to have the special quality of permitting more light to reach the firer's eye and of giving him a better view of the target when the sights were aligned under conditions of limited visibility. Under these same circumstances of flare illumination at night, both the Armalite and M-14 had almost identical hit capability. Under daylight conditions this special situation no longer existed and the M-14 and the Winchester were again nearly the same in achieving hits.

The hits achieved by all three rifle types at night under conditions of flare illumination appear to have tactical significance. As an example, squads armed with a lightweight high-velocity rifle (as represented by Winchester) were able to score, while firing at night under flares, fully 30 percent as many hits as they were able to score in daylight.

(b) Under conditions of darkness (non-illuminated) none of the three rifle types demonstrated an aimed hit

capability at any of the three ranges (100, 200, 300 yds). The hits scored never exceeded seven per thousand rounds of ammunition fired. The hits scored were random and there was no statistical difference between the LWHVR system and the M-14 (See Table 17). Since enemy tactical doctrine emphasizes night operations, it seems desirable that the squad be capable of defending itself at night, preferably at ranges greater than 50 yards. It is suggested that this could be accomplished in two ways. The defensive capability of the squad at night could be enhanced by keeping the squad battle zone under continuous illumination, or by placing within the squad an area weapon capable of augmenting the destructive firepower organic to the squad under conditions of restricted visibility. In this regard reference is made to Final Report - Evaluation of NIBLICK (U) (CDOG, CDEC 58T10).

4. AIDS TO FIRING

a. Tracer Ammunition

Observation of the results of tracer fire at night (using the M-14 only) under both illuminated and non-illuminated conditions did not indicate that tracer had any significant value in increasing the number of hits per hundred rounds fired. It is recognized, however, that tracer has value in designating and outlining targets and target areas.

b. Bipods

The use of bipods was examined with the M-14 and the Armalite. The results were negative. In accounting for their lower scores with bipods, the firers felt the bipods acted as a drag on the rapid shifting of the rifle from target to target and also impeded quick aiming.

TABLE 16

HITS/RUN AT 100 YARD - RANGE

5-MAN SQUADS

RUN NUMBER	ARMALITE AR-15	M-14
1	14	19
2	34	17
3	24	15
4	23	16
5	22	13
6	38	18
7	44	32
8	32	19
TOTAL NO. OF HITS	231	149
AVERAGE NO. OF HITS	28.9	18.6

TABLE 17

SELECTED PHASE III (NIGHT) PERFORMANCE VALUES - SEMI-AUTOMATIC

	NO FLARES		FLARES			
	Total Nr Rds Fired	Total Nr Hits	Rds	Hits	Nr Hits Per Rds Fired	Hits Per Rds Fired Night/ Hits Per Rds Fired Daylight
TOTAL						
W	4194	16	4127	315	.0763	29.5%
A	4406	28	4259	249	.0585	26.2%
N	4316	29	4359	258	.0592	22.9%
100 YD RANGE						
W	971	7	1115	147	.1318	27.4%
A	849	16	1092	124	.1136	25.8%
N	1010	10	1174	122	.1039	22.1%
200 YD RANGE						
W	1330	5	1172	82	.0700	24.1%
A	1358	5	1198	70	.0584	24.3%
N	1458	7	1200	85	.0708	26.5%
300 YD RANGE						
W	1893	4	1840	86	.0467	37.8%
A	2199	7	1969	55	.0279	28.3%
N	1848	12	1985	51	.0257	19.4%

ANNEX A

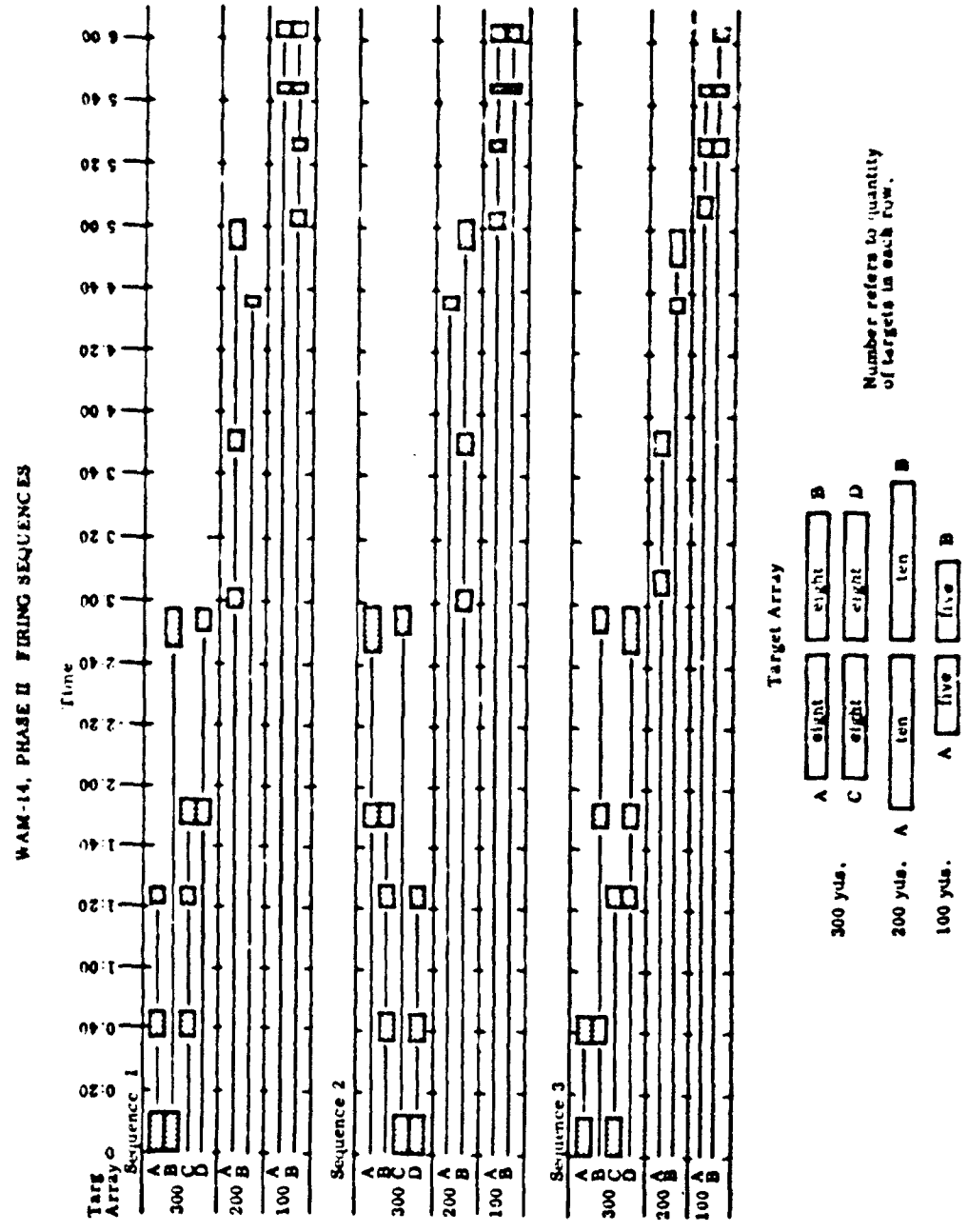
LWHVR EXPERIMENT REPORT

DESIGNS OF EXPERIMENT

Designs and schedules of the experimentation are presented in detail in the succeeding tables of this section.

Details of the arrangement and sequence of target arrays are illustrated in the figure immediately following (page A-2).

In all tables, the designations W, A, and M refer respectively to the Winchester, Armalite and M-14 rifles.



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DESIGN OF EXPERIMENT

ATTACK PHASE: SEMI-AUTOMATIC FIRE, DAYLIGHT

DAY		1	2	3		4	5	6			7	8	9		10	11	12
RANGE		I	I	I		II	II	II			I	I	I		II	II	II
PLATOON		1	2	3		1	2	3			1	2	3		1	2	3
Target Array	Squad Size				Squad Size				Target Array	Squad Size				Squad Size			
1	7	W	M	A	9	W	M	A	3	5	A	M	W	11	A	M	W
1	9	W	M	A	7	W	M	A	3	11	A	M	W	5	A	M	W
2	5	W	M	A	11	W	M	A	2	7	A	M	W	9	A	M	W
2	11	W	M	A	5	W	M	A	2	9	A	M	W	7	A	M	W
3	7	A	A	W	9	M	W	M	1	5	M	A	M	11	W	W	A
3	9	A	A	W	7	M	W	M	1	11	M	A	M	5	W	W	A
1	5	A	A	W	11	M	W	M	3	7	M	A	M	9	W	W	A
1	11	A	A	W	5	M	W	M	3	9	M	A	M	7	W	W	A
2	7	M	W	M	9	A	A	W	2	5	W	W	A	11	M	A	M
2	9	M	W	M	7	A	A	W	2	11	W	W	A	5	M	A	M
3	5	M	W	M	11	A	A	W	1	7	W	W	A	9	M	A	M
3	11	M	W	M	5	A	A	W	1	9	W	W	A	7	M	A	M

Additional designs for Defense. Night & other variables

DESIGN OF EXPERIMENT

DEFENSE PHASE: SEMI-AUTOMATIC FIRE, DAYLIGHT

Day 1			Day 2			Day 3			Day 4			Day 5			Day 6		
PLATOON		1 2	PLATOON		2 1	PLATOON		1 2	PLATOON		2 1	PLATOON		1 2	PLATOON		2 1
Target Array	Squad Size		Target Array	Squad Size		Target Array	Squad Size		Target Array	Squad Size		Target Array	Squad Size		Target Array	Squad Size	
1	11	A A	2	7	A A	3	11	M M	2	7	W W	2	11	W W	3	7	M M
1	5	A A	2	9	A A	3	5	M M	2	8	W W	2	5	W W	3	9	M M
2	9	A A	1	5	A A	1	9	M M	3	5	W W	3	9	W W	2	5	M M
2	7	A A	1	11	A A	1	7	M M	3	11	W W	3	7	W W	2	11	M M
3	11	W W	2	7	M M	2	11	A A	1	7	A A	1	11	M M	1	7	W W
3	5	W W	2	9	M M	2	5	A A	1	9	A A	1	5	M M	1	9	W W
1	9	W W	3	5	M M	3	9	A A	3	5	A A	2	9	M M	1	5	W W
1	7	W W	3	11	M M	3	7	A A	3	11	A A	2	7	M M	1	11	W W
2	11	M M	3	7	W W	1	11	W W	1	7	M M	3	11	A A	3	7	A A
2	5	M M	3	9	W W	1	5	W W	1	9	M M	3	5	A A	3	9	A A
3	9	M M	2	5	W W	2	9	W W	1	5	M M	1	9	A A	2	5	A A
3	7	M M	2	11	W W	2	7	W W	1	11	M M	1	7	A A	2	11	A A
1	11	A A	2	7	A A	3	11	M M	2	7	W W	2	11	W W	2	7	M M
1	4	A A	2	9	A A	3	5	M M	2	9	W W	2	5	W W	3	9	M M
2	9	A A	1	5	A A	1	9	M M	3	5	W W	3	9	W W	2	5	M M
2	7	A A	1	11	A A	1	7	M M	3	11	W W	3	7	W W	2	11	M M
3	11	W W	2	7	M M	2	11	A A	1	7	A A	1	11	M M	1	7	W W
3	5	W W	2	9	M M	2	5	A A	1	9	A A	1	5	M M	1	9	W W
1	9	W W	3	5	M M	3	9	A A	3	5	A A	2	9	M M	1	5	W W
1	7	W W	3	11	M M	3	7	A A	3	11	A A	2	7	M M	1	11	W W
2	11	M M	3	7	W W	1	11	W W	1	7	M M	3	11	A A	3	7	A A
2	5	M M	3	9	W W	1	5	W W	1	9	M M	3	5	A A	3	9	A A
3	9	M M	2	5	W W	2	9	W W	1	5	M M	1	9	A A	2	5	A A
3	7	M M	2	11	W W	2	7	W W	1	11	M M	1	7	A A	2	11	A A

DEFENSE PHASE: SEMI-AUTOMATIC FIRE, NIGHT WITHOUT ARTIFICIAL ILLUMINATION

Day 1			Day 2		
PLATOON		1 2	PLATOON		1 2
Target Array	Squad Size		Target Array	Squad Size	
1	11	A A	2	7	A A
1	5	A A	2	9	A A
2	9	A A	1	5	A A
2	7	A A	1	11	A A
3	11	W W	2	7	M M
3	5	W W	2	9	M M
1	9	W W	3	5	M M
1	7	W W	3	11	M M
2	11	M M	3	7	W W
2	5	M M	3	9	W W
3	9	M M	2	5	W W
3	7	M M	2	11	W W
1	11	A A	2	7	A A
1	5	A A	2	9	A A
2	9	A A	1	5	A A
2	7	A A	1	11	A A
3	11	W W	2	7	M M
3	5	W W	2	9	M M
1	9	W W	3	5	M M
1	7	W W	3	11	M M
2	11	M M	3	9	W W
2	5	M M	3	9	W W
3	9	M M	2	5	W W
3	7	M M	2	11	W W

DESIGN OF EXPERIMENT

DEFENSE PHASE: SEMI-AUTOMATIC FIRE, NIGHT WITH FLARE ILLUMINATION

Day 3				Day 4			
PLATOON		1	2	PLATOON		1	2
Target Array	Squad Size			Target Array	Squad Size		
3	11	M	M	2	7	W	W
3	5	M	M	2	9	W	W
1	9	M	M	3	5	W	W
1	7	M	M	3	11	W	W
2	11	A	A	1	7	A	A
2	5	A	A	1	9	A	A
3	9	A	A	3	5	A	A
3	7	A	A	3	11	A	A
1	11	W	W	1	7	M	M
1	5	W	W	1	9	M	M
2	9	W	W	1	5	M	M
2	7	W	W	1	11	M	M
3	11	M	M	2	7	W	W
3	5	M	M	2	9	W	W
1	9	M	M	3	5	W	W
1	7	M	M	3	11	W	W
2	11	A	A	1	7	A	A
2	5	A	A	1	9	A	A
3	9	A	A	3	5	A	A
3	7	A	A	3	11	A	A
1	11	W	W	1	7	M	M
1	5	W	W	1	9	M	M
2	9	W	W	1	5	M	M
2	7	W	W	1	11	M	M

DESIGN OF EXPERIMENT

DEFENSE PHASE: MIXED AUTOMATIC AND SEMI-AUTOMATIC FIRE, NIGHT

Target Array	Squad Size	Rifle	Bipod	Auto	Semi	Flares
1	5 of 7	M	No	1/3 tracer		No
1	7 of 9	M	No	1/3 tracer		No
2	5 of 7	M	No		Full tracer	No
2	7 of 9	M	No		full tracer	No
1	7	A	Yes	No tracer		No
1	9	A	Yes	Nc tracer		No
2	5	A	Yes	No tracer		No
2	11	A	Yes	No tracer		No
1	7	A	No	No tracer		No
1	9	A	No	No tracer		No
2	5	A	No	No tracer		No
2	11	A	No	No tracer		No
1	5 of 7	M	Yes	1/3 tracer		No
1	7 of 9	M	Yes	1/3 tracer		No
2	5 of 7	M	Yes		full tracer	No
2	7 of 9	M	Yes		full tracer	No
1	5 of 7	M	Yes	1/3 tracer		Yes
1	7 of 9	M	Yes	1/3 tracer		Yes
2	5 of 7	M	Yes		full tracer	Yes
2	7 of 9	M	Yes		full tracer	Yes

*Platoon 1 Firing

DESIGN OF EXPERIMENT

DEFENSE PHASE: AUTOMATIC FIRE, NIGHT WITH FLARE ILLUMINATION

Run #	Squad Size	Rifle	Biped
1	7	A	Yes
2	9	A	Yes
3	5	A	Yes
4	11	A	Yes
5	5 of 7	M	Yes
6	7 of 9	M	Yes
7	7	A	No
8	9	A	No
9	5	A	No
10	11	A	No
11	5 of 7	M	No
12	7 of 9	M	No

DEFENSE PHASE: AUTOMATIC FIRE, DAYLIGHT

Day 1			Day 2		
PLATOON		1 2	PLATOON		1 2
Target Array	Squad Size		Target Array	Squad Size	
1	5	W	3	5	A
1	9	W	3	9	A
1	7	W	3	7	A
1	11	M*	3	11	M*
2	5	A	2	5	W
2	9	A	2	9	W
2	7	A	2	7	W
2	11	M*	2	11	M*
3	5	W	1	5	A
3	9	W	1	9	A
3	7	W	1	7	A
3	11	M*	1	11	M*
1	11	M*	3	11	M*
1	7	A	3	7	W
1	9	A	3	9	W
1	5	A	3	5	W
2	11	M*	2	11	M*
2	7	W	2	7	A
2	9	W	2	9	A
2	5	W	2	5	A
3	11	M*	1	11	M*
3	7	A	1	7	W
3	9	A	1	9	W
3	5	A	1	5	W

*For these particular runs, the squad was armed with eight M-14 rifle or semi-automatic fire and two M-14 rifles on automatic fire. These substituted for the eight M-1 rifles and two BARs assigned under ROCID (Reorganized Combat Infantry Division), TO&E 7-17c.

DEFENSE PHASE: AUTOMATIC FIRE, DAYLIGHT

(Limited ammunition supply — reduced from 140 rounds per firer to 80 rounds)

Target Array	Squad Size	Rifle
3	5	A
2	9	A
1	5	A
2	9	A
3	5	A
3	9	A
2	5	A
1	9	A

DESIGN OF EXPERIMENT

DEFENSE PHASE: MIXED AUTOMATIC AND SEMI-AUTOMATIC FIRE, DAYLIGHT

Day 1						Day 2						Day 3						
PLATOON 2, morning PLATOON 1, afternoon						PLATOON 2, morning PLATOON 1, afternoon						PLATOON 1						
Target Array	Squad Size	Rifle	Auto	Semi	Bipod	Target Array	Squad Size	Rifle	Auto	Semi	Bipod	Target Array	Squad Size	Rifle	Type of Fire 300 yards	200 yards	100 yards	Bipod
2	11	A	2	8	(2 ARs only)	2	5	M	all		No	1	7	M	SA	SA	A	Yes
1	7	M	all		Yes	1	9	A		all	No	1	9	M	SA	SA	A	Yes
1	9	A	all		Yes	1	7	M	all		No	2	7	A	SA	SA	SA	Yes
2	5	M	all		Yes	2	11	A	2	8	No	2	9	A	SA	SA	SA	Yes
2	11	A	all			2	5	A	all		Yes	2	7	A	SA	SA	A	Yes
1	7	A	all			1	9	A		all	Yes	2	9	A	SA	SA	A	Yes
1	9	A	4	4	(4 ARs only)	1	7	A		all	No	1	7	M	SA	SA	SA	Yes
2	5	A	all			2	11	A	all		No	1	9	M	SA	SA	SA	Yes
2	11	A	2	8	No	2	5	M	all		Yes	1	7	A	SA	SA	A	No
1	7	M	all		No	1	9	A	all		Yes	1	9	A	SA	SA	A	No
1	9	A		all	No	1	7	M	all		Yes	2	7	M	SA	SA	SA	No
2	5	M	all		No	2	11	A	2	8	(2 ARs only)	2	9	M	SA	SA	SA	No
2	11	A	all		No	2	5	A	all		Yes	2	7	M	SA	SA	A	No
1	7	A		all	No	1	9	A	4	4	(4 ARs only)	2	9	M	SA	SA	A	No
1	9	A		all	Yes	1	7	A	all		Yes	1	7	A	SA	SA	SA	No
2	5	A	all		Yes	2	11	A	all		Yes	1	9	A	SA	SA	SA	No

DESIGN OF EXPERIMENT

DEFENSE PHASE: M-14 RIFLE, SEMI-AUTOMATIC FIRE
LIGHTWEIGHT RIFLES, AUTOMATIC AND SEMI-AUTOMATIC FIRE

Target Array	Squad Size	Rifle	Type of Fire		
			300 yds	200 yds	100 yds
1	7	A	SA	SA	A
2	7	W	SA	SA	A
1	7	M	SA	SA	SA
2	7 of 11	A	SA	SA	A
2	7 of 11	M	SA	SA	SA
2	7	M	SA	SA	SA
1	7	A	SA	A	A
1	7 of 11	M	SA	SA	SA
2	7 of 11	A	SA	A	A

ANNEX B

LWHVR EXPERIMENT REPORT

DATA FORMS

This annex contains the forms used by the data collectors and hit counters to record the information obtained by them during each of the 559 runs in the LWHVR experiment.

The forms are self-explanatory with a few exceptions, listed below:

a. "Firers index" refers to the relative marksmanship proficiency standing as derived from pre-experiment firing.

b. "Span number" refers to the relative position on the line of each firer during each run.

c. "Weapon type and number" refers (in addition to the rifle type) to the special number given each rifle used in the experiment.

DAYLIGHT ATTACK

Circle Weather: Cloudy Sunny Raining Hot Cold Moderate

Circle Range #: 1 2 Date: Month:_____ # Of Day Of Month_____

Circle Cman #: 1 2 3 4 5 6 7 8 9 10 11

Firer's Name_____Serial #_____

Run #_____Firer's Index_____Platoon #_____

Circle Weapon Type and #: Armalite Winchester M14

1 2 3 4 5 6 7 8 9 10 11

Of Rounds Issued To Firer:_____

Place "Y" in Blank After Insuring that Weapon is Set for Semi-Automatic_____

Circle # of Men in Squad: 5 6 7 8 9 11

Run Starting Time: Hours_____Minutes_____

TARGET #	Circle # of Rounds Fired or Write # if # Not Listed	Check if No Fire	Circle # of Stoppages or Write # if # Not Listed	Circle # of Rounds Fired After Whistle or Write # if # Not Listed
1	0 1 2 3 4 5 6 7 8 9___	_____	1 2 3 4 5___	1 2 3____
2	0 1 2 3 4 5 6 7 8 9___	_____	1 2 3 4 5___	1 2 3____
3	0 1 2 3 4 5 6 7 8 9___	_____	1 2 3 4 5___	1 2 3____
4	0 1 2 3 4 5 6 7 8 9___	_____	1 2 3 4 5___	1 2 3____
5	0 1 2 3 4 5 6 7 8 9___	_____	1 2 3 4 5___	1 2 3____
6	0 1 2 3 4 5 6 7 8 9___	_____	1 2 3 4 5___	1 2 3____
7	0 1 2 3 4 5 6 7 8 9___	_____	1 2 3 4 5___	1 2 3____

TOTALS:_____

Remarks: Nature of Failure or Damage to Weapon_____

_____

Cause:_____Result:_____

Recorders Name:_____Serial #_____

REMARKS:

DAYLIGHT ATTACK (Hit Count)

Circle Range #: 1 2 Circle Weapon Type: Armalite Winchester M-14

DATE: Month_____ of Day of Month_____

Circle Span #: 1 2 3 4 5 6 7 8 9 10 11

Circle Target Array: Red White Blue

Run #_____

Platoon #_____

Run Starting Time: Hours_____ Minutes_____

Target Number	Circle Number of Hits Scored on each target, or write number in the blank space if the number is not listed.											
1	0	1	2	3	4	5	6	7	8	9	10	_____
2	0	1	2	3	4	5	6	7	8	9	10	_____
3	0	1	2	3	4	5	6	7	8	9	10	_____
4	0	1	2	3	4	5	6	7	8	9	10	_____
5	0	1	2	3	4	5	6	7	8	9	10	_____
6	0	1	2	3	4	5	6	7	8	9	10	_____
7	0	1	2	3	4	5	6	7	8	9	10	_____

TOTAL_____

COUNTERS NAME_____ SERIAL NO._____

REMARKS:

DAYLIGHT POSITION DEFENCE (Automatic Fire)

Date: Month # _____ # of day of month _____

Circle target sequence: 1 2 3

Run # _____ Circle platoon #: 1 2 3

Circle # of men in squad: 5 6 7 8 9 11

Circle weapon type and #: Armalite Winchester M. 14

1 2 3 4 5 6 7 8 9 10 11

Firer's name: _____ Serial # _____

# of rounds issued to firer: _____

Place "X" in blank after insuring that weapon is set for automatic fire: _____

Run starting time: Hours _____ Minutes _____

Circle # of stoppages or write # if # not listed:

1 2 3 4 5 6 7 8 9 10 ____

# of rounds firer has left at end of run: _____

Remarks: Nature of weapon failure or damage _____

_____

Cause: _____ Result: _____

General Comments:

Recorder's name: _____

DAYLIGHT POSITION DEFENSE (Semi-Automatic Fire)

Date: Month #_____ # of day of month _____

Circle target sequence: 1 2 3

Run #_____ Circle Platoon #: 1 2 3

Circle # of men in squad: 5 7 9 11

Circle weapon type and #: Armalite 1 2 3 4 Winchester 5 6 7 M14 8 9 10 11

Firer's name: _____ Serial #_____

# of rounds issued to firer: _____

Place "X" in blank after insuring that weapon is set for semi-automatic fire: _____

Run starting time: Hours _____ Minutes _____

Distance to targets (yards)	Circle # of rounds fired or write # if # not listed	Circle # of stoppages or write # if # not listed
300	0 1 2 3 4 5 ____	0 1 2 3 ____
200	0 1 2 3 4 5 ____	0 1 2 3 ____
100	0 1 2 3 4 5 ____	0 1 2 3 ____

# of rounds firer has left at end of run: _____

Remarks: Nature of weapon failure or damage _____

_____

Cause: _____ Results _____

General Comments: _____

Recorder's name: _____

BEST AVAILABLE COPY

DAYLIGHT POSITION DEFENSE

Circle weather: Cloudy Sunny Raining Wet Cold Moderate
Date: Month # _____ # of day of month _____
Circle target sequence: 1 2 3
Run # _____ Circle platoon #: 1 2 3
Circle # of men in squad: 5 3 7 8 9 11
Circle distance to firing line (yds): 300 200 100 50
Circle weapon type: Armalite Winchester M 14
Place " X " in blank after insuring that all lit switches and wiring are intact and in good operating condition. ____
Time recorders are activated: Hours _____ Minutes _____
Time recorders are stopped: Hours _____ Minutes _____
Run starting time.: Hours _____ Minutes _____
Upon completion of a run, write both the number and the starting time of that run on the recorder chart and then place an " X " here: _____

TARGET #	Circle # of hits or write # if # not listed	
1	0 1 2 3 4 5	_____
2	0 1 2 3 4 5	_____
3	0 1 2 3 4 5	_____
4	0 1 2 3 4 5	_____
5	0 1 2 3 4 5	_____
6	0 1 2 3 4 5	_____
7	0 1 2 3 4 5	_____
8	0 1 2 3 4 5	_____
9	0 1 2 3 4 5	_____
10	0 1 2 3 4 5	_____
11	0 1 2 3 4 5	_____
12	0 1 2 3 4 5	_____
13	0 1 2 3 4 5	_____
14	0 1 2 3 4 5	_____
15	0 1 2 3 4 5	_____
16	0 1 2 3 4 5	_____
17	0 1 2 3 4 5	_____
18	0 1 2 3 4 5	_____
19	0 1 2 3 4 5	_____
20	0 1 2 3 4 5	_____
21	0 1 2 3 4 5	_____
22	0 1 2 3 4 5	_____
23	0 1 2 3 4 5	_____
24	0 1 2 3 4 5	_____
25	0 1 2 3 4 5	_____
26	0 1 2 3 4 5	_____
27	0 1 2 3 4 5	_____
28	0 1 2 3 4 5	_____
29	0 1 2 3 4 5	_____
30	0 1 2 3 4 5	_____
31	0 1 2 3 4 5	_____
32	0 1 2 3 4 5	_____

TOTAL _____

Recorder's name: _____

NIGHT POSITION DEFENSE

Circle weather: cool cold raining cloudy clear
moon phase: dark quarter half full
Date: Month # _____ # of day of month _____
Circle target sequence: 1 2 3
Run # _____ Circle platoon #: 1 2 3
Circle # of men in squad: 5 7 9 11
Circle distance to firing line (yds): 300 200 125 60
Circle weapon type: Armalite Winchester M14
Place "X" in blank after inserting that all hit switches and wiring are intact and in good operating condition. _____
Time recorders are activated: Hours _____ Minutes _____
Time recorders are stopped: Hours _____ Minutes _____
Run starting time: Hours _____ Minutes _____
Upon completion of a run, enter specified information on the recorder chart.

TARGET #	Circle # of hits or write # if # not listed	
1	0 1 2 3 4 5	_____
2	0 1 2 3 4 5	_____
3	0 1 2 3 4 5	_____
4	0 1 2 3 4 5	_____
5	0 1 2 3 4 5	_____
6	0 1 2 3 4 5	_____
7	0 1 2 3 4 5	_____
8	0 1 2 3 4 5	_____
9	0 1 2 3 4 5	_____
10	0 1 2 3 4 5	_____
11	0 1 2 3 4 5	_____
12	0 1 2 3 4 5	_____
13	0 1 2 3 4 5	_____
14	0 1 2 3 4 5	_____
15	0 1 2 3 4 5	_____
16	0 1 2 3 4 5	_____
17	0 1 2 3 4 5	_____
18	0 1 2 3 4 5	_____
19	0 1 2 3 4 5	_____
20	0 1 2 3 4 5	_____
21	0 1 2 3 4 5	_____
22	0 1 2 3 4 5	_____
23	0 1 2 3 4 5	_____
24	0 1 2 3 4 5	_____
25	0 1 2 3 4 5	_____
26	0 1 2 3 4 5	_____
27	0 1 2 3 4 5	_____
28	0 1 2 3 4 5	_____
29	0 1 2 3 4 5	_____
30	0 1 2 3 4 5	_____
31	0 1 2 3 4 5	_____
32	0 1 2 3 4 5	_____

TOTAL _____

Recorder's name: _____

ANNEX C

L'VHVR EXPERIMENT REPORT

OPINION POLL

This annex contains a copy of the "Military Information Check Sheet" used in obtaining opinions on the candidate rifles from 32 of the riflemen who participated in the L'VHVR experiment. The sample size was not larger due to attrition to the original experimentation forces brought about by transfers, illness, leaves, etc.

W A M - 14

MILITARY INFORMATION CHECK SHEET

NAME: _____ SERIAL NUMBER: _____
(Last) (First) (Initial)

DATE COMPLETED: _____

INSTRUCTIONS

Please answer these questions after you have fired all the weapons. Your opinions will help decide which weapons are "best" for certain purposes.

Please give a frank answer to every question. Some of the questions will be hard to answer. For example, you may think that all three of the weapons are about equal in certain things. Even when this is the case, force yourself to make the choices that are asked for. If you wish to explain any of your answers, please comment in the spaces provided.

Thanks for your help in this very important project.

DIRECTIONS

Put an X in the space that best describes your opinion. If you do not find an answer that exactly fits your ideas, put an X opposite the one answer that comes closest to it, or write in your own answer in the space provided for comments.

1. Some rifles seem to be better balanced than others--they just "feel" right. Which rifle did you think had the best "feel"?

	Armalite	Winchester	M-14
The best rifle was (check one).....	___	___	___

2. Some people like a heavy rifle and others prefer a lighter one. Which rifle did you think had the best weight?

	Armalite	Winchester	M-14
The best rifle was (check one).....	___	___	___

3. The sights on these three rifles are a little bit different from each other. Which one did you think was best?

	Armalite	Winchester	M-14
The best rifle was (check one).....	___	___	___

4. Some rifles seem to be tougher--can "take it" better--than others. Which of these rifles do you think would stand up best under combat conditions?

	Armalite	Winchester	M-14
The best rifle was (check one).....	___	___	___

5. Each of these rifles has a different kind of grip. Most people prefer one kind of grip to another. Which grip did you like best?

	Armalite	Winchester	M-14
The best rifle was (check one).....	___	___	___

6. Some rifles seem to be easier to load than others. Which of these rifles did you think was easiest to load?

	Armalite	Winchester	M-14
The easiest rifle was (check one).....	___	___	___

7. You've had a chance to load each of these rifles. Which one could you load most quickly?

	Armalite	Winchester	M-14
The quickest rifle was (check one)....	___	___	___

8. Besides loading the rifles, you had to do some other things to each of them before you could fire--for example, release the safety. Which rifle was the easiest to get ready to use?

	Armalite	Winchester	M-14
The easiest rifle was (check one).....	___	___	___

9. Each of these weapons had to be taken apart in different ways. Which rifle was the easiest to take apart?

	Armalite	Winchester	M-14
The easiest rifle was (check one).....	___	___	___

10. Some rifles are easier to clean in the field than others. Which of these rifles was the easiest to clean in the field?

	Armalite	Winchester	M-14
The easiest rifle was (check one).....	___	___	___

11. Some rifles have greater recoil than others. Which rifle did you like best from the point of view of recoil?

	Armalite	Winchester	M-14
The best rifle was (check one).....	___	___	___

12. Some rifles are harder than others to get back on target after a round has been fired. Which of these rifles seemed best -- that is, returned quickest?

	Armalite	Winchester	M-14
The most accurate rifle was (check one)	___	___	___

13. Probably you made better scores with one of these rifles than with the others. Which one seemed to be most accurate for you?

	Armalite	Winchester	M-14
The most accurate rifle was (check one)	___	___	___

14. Some rifles just seem to be more dependable than others. Others can't be trusted so much. Which of these rifles seemed to you to be most dependable?

	Armalite	Winchester	M-14
The most dependable rifle was..... (check one)	___	___	___

15. In your opinion, which of these three rifles would be the all-around best one for the infantry to use? Try to consider all the things that are important to you -- weight, long and short range accuracy, dependability, ease of use, caliber of ammunition, and so on. Which one do you think would be best?

	Armalite	Winchester	M-14
The best all-around rifle would be.. (check one)	___	___	___

16. If you had a choice between (1) a larger caliber round (such as .30 caliber -- the standard NATO round) and (2) a smaller caliber round (such as the .22 caliber Winchester round), which would you prefer for combat use? (check one box only.)

___ Prefer the larger caliber ammunition
___ Prefer the smaller caliber ammunition
___ Have no preference between the two

17. Some rifles are likely to "climb" when they are on automatic fire. Which of these rifles did you think was best (climbed the least) when on automatic fire?

	Armalite	Winchester	M-14
The best rifle was (check one).....	___	___	___

18. Some rifles have trigger backlash. Which rifle did you think had the least trigger backlash?

	Armalite	Winchester	M-14
Least trigger backlash (check one)...	___	___	___

19. Some rifles work better than other rifles when it's raining. Which rifle did you think worked best in the rain?

	Armalite	Winchester	M-14
Worked best in the rain (check one)..	___	___	___

20. Some rifles may fire more accurately than others on full automatic. Which rifle do you think fires most accurately on full automatic?

	Armalite	Winchester	M-14
Most accurate on full automatic..... (check one)	___	___	___

21. Some rifles may malfunction more often than others on full automatic? Which rifle do you think malfunctions most often on full automatic?

	Armalite	Winchester	M-14
Malfunctions most often on full automatic (check one).....	___	___	___

22. In combat, which rifle do you think most of the other VAM-14 firers would want to use?

	Armalite	Winchester	M-14
The rifle they would like best is (check one).....	___	___	___

23. Which rifle do you think is liked best by the people running the experiment?

	Armalite	Winchester	M-14
The rifle liked best by the people running the experiment is (check one)	___	___	___

24. If you were in night combat and flares were being used:

a. Would you rather fire automatically_____, or semi-automatically _____?(Check one)

b. Would you rather fire tracer ammunition_____, or not fire tracer ammunition_____? (Check one)

c. Would you rather use a bipod for your rifle _____, or a sandbag_____, or neither _____? (Check one)

d. Which rifle would you rather use, the Armalite _____, the Winchester _____, or the M-14 _____? (Check one)

25. If you were in combat and no flares were being used:

a. Would you rather fire automatically ____, or semi-automatically ____? (Check one)

b. Would you rather fire tracer ammunition ____, or not fire tracer ammunition ____? (Check one)

c. Would you rather use a bipod for your rifle ____, or a sandbag ____, or neither ____? (Check one)

d. Which rifle would you rather use, the Armalite ____, the Winchester ____, or the M-14 ____? (Check one)

26. Which rifle do you think is most deadly at 300 yards:

The Armalite ____, the Winchester ____, or the M-14 ____? (Check one)

27. Which rifle do you think is most deadly at 200 yards:

The Armalite ____, the Winchester ____, or the M-14 ____? (Check one)

28. Which rifle do you think is most deadly at 100 yards:

The Armalite ____, the Winchester ____, or the M-14 ____? (Check one)

29. Give what you think is the one most important advantage of the Armalite rifle.

_____

_____

30. Give what you think is the one most important advantage of the Winchester rifle.

_____

_____

31. Give what you think is the one most important advantage of the M-14 rifle.

_____

_____

32. Give what you think is the one most important disadvantage of the Armalite rifle.

_____

_____

33. Give what you think is the one most important disadvantage of the Winchester rifle.

_____

_____

34. Give what you think is the one most important disadvantage of the M-14 rifle.

_____

_____

C. If you will be transferring to another military unit within the next few weeks, give the name of the unit to which you will be assigned. State whether PCS or TDY. _____

ANNEX D

LWHVR EXPERIMENT REPORT

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RIFLE SQUAD ARMED WITH A LIGHTWEIGHT HIGH-VELOCITY RIFLE

4 DESCRIPTIVE NOTES (Type of report and inclusive dates)

Final Report

5 AUTHOR(S) (Last name, first name, initial)

US Army Combat Developments Command Experimentation Command
Fort Ord, California 93941

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A field experiment was conducted to determine the relative effectiveness of variously organized rifle squads armed with M-14 rifles and Winchester and Armalite lightweight, high-velocity rifles (LWHVRs). A schedule was established to measure differences in the weapons based on their relative target hit capabilities. More than 500 firing runs were made on two attack ranges and one defense range. The target hits were counted manually and by mechanical event recorders. Different fire techniques and combinations of techniques were studies, and four different squad sizes were examined to accumulate data bearing on the appropriate size for squads using these weapons.

studied,

DD FORM 1 JAN 64 1473

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KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Lightweight High-Velocity Rifle (LHVR)						
Squad size						
Rifle Squad						
Firing Techniques						
Target Hits						
Hit Distribution						
Hit Capability						
Firing Runs						
M14 .30-caliber Rifle						
Winchester .224-caliber Lightweight Rifle						
Armalite .222-caliber Lightweight Rifle						

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